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Orange County Water District
Fountain Valley, CA

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ADVANCED TREATMENT FOR WASTEWATER RECLAMATION AT WATER FACTORY 21

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16. ABSTRACT

The performance and reliability of Water Factory 21 (WF21) in Orange County, California, for removal of a broad range of organic, inorganic, and biological contaminants from activated-sludge treated municipal wastewater was evaluated. This full-scale facility has a capacity of 0.66 m^3/s (15 MGD) and includes chemical treatment, air stripping, activated carbon adsorption, reverse osmosis treatment, and disinfection. WF21 furnishes reclaimed water for a hydraulic barrier that prevents intrusion of sea water into the local fresh water aquifer. This report is the final one of three reports describing the operation over a five-year period, and covers the last three-year period when analyses were most intensive.

The objective of this study was to provide sufficient long-term data on performance, reliability, and cost of full-scale advanced wastewater treatment to aid in the evaluation of its feasibility for the production of reclaimed water for potable use. Operational problems and costs of treatment were documented, the statistical reliability of the treatment system to meet current EPA drinking water regulations was evaluated, the efficiency of the various processes and the overall system to remove trace contaminants was determined, the effectiveness of the system in removing (or producing) mutagenic materials was documented, and potential surrogate parameters to serve as indicators of the effectiveness of treatment for contaminants of concern were evaluated.

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FOREWORD

The Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution and it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems for the prevention, treatment, and management of wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, for the preservation and treatment of public drinking water supplies, and for minimizing the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research; a most vital communications link between the researcher and the user community.

This is the final in a series of three (3) reports which provide detailed characterizations of the performance of Water Factory 21, a 0.66 m^3/s advanced wastewater treatment plant designed to treat municipal wastewater so that it can be used to recharge a groundwater system. Through this project groundwater supplies are being replenished, saltwater-endangered aquifiers are being protected, and water is being reclaimed for future use.

Francis T. Mayo, Director
Municipal Environmental
Research Laboratory

ABSTRACT

Water Factory 21 (WF21) is a 0.66 m^3/s (15 mgd) advanced wastewater treatment plant in California that is operated by the Orange County Water District. The reclaimed water produced is used to supply injection water for a hydraulic barrier to prevent sea-water intrusion into the local groundwater supply. The processes used at WF21 to reclaim secondary-treated municipal wastewater are lime treatment, air stripping, recarbonation, filtration, granular activated carbon adsorption (GAC), reverse osmosis (RO), and chlorination. The water produced by this series of processes is of high quality and there is interest in its potential for augmenting a drinking water supply. This report contains the results of a broad investigation to evaluate the quality of the reclaimed water and the reliability of WF21 so that judgments might be made of its potential for such a purpose.

This study covered a three-year period from March 1978 through March 1981 when WF21 received municipal wastewater that had been treated by the activated sludge process. WF21 can be considered as two separate plants, one termed the advanced wastewater treatment (AWT) plant consisting of all processes through final chlorination, but excluding RO treatment. The second (AWT plus RO) includes all processes including RO treatment, but excludes final chlorination. During this study, the efficiency of the various unit processes and that of the two overall treatment plants was evaluated. Extensive analyses were conducted for inorganic constituents including heavy metals, a range of organic compounds, and biological quality including virus and indicator bacteria. During the last year, a more intensive study was conducted that included analyses for most compounds on the EPA list of priority pollutants and a range of additional organic materials that had not previously been identified. Also conducted were analyses for parasites and for the mutagenic activity of concentrated water extracts. Statistical analyses were conducted to determine the variability in water quality at various sampling locations and of the removals that were obtained.

The effluent from the AWT plant with and without RO treatment met the interim primary EPA drinking water regulations more than 95 percent of the time (except for coliforms in the non-chlorinated RO effluent). Effluent from AWT treatment alone met all EPA secondary standards measured except for pH and general mineral parameters such as total dissolved solids, chlorides, and sulfates. AWT plus RO treatment resulted in water meeting all the measured secondary standards at least 95 percent of the time. However no measurements were made for odor or corrosivity. Since no comprehensive standards and criteria currently exist to define potable water regardless of source, none of the above should be construed to mean that the described product was potable.

AWT with and without RO treatment produced an effluent that met on the average most of the health criteria at the 10^{-6} lifetime risk level developed for those priority pollutants not currently regulated by EPA interim primary

regulations or secondary standards and for which the criteria concentrations were above the analytical limits for the procedures used. However, no judgements can be made for several compounds for which the criteria concentrations were below the analytical detection limit of 10 to 100 ng/l, nor for priority pollutants that could not be quantified by the procedures used. Also, the list of priority pollutants does not include all potentially toxic chemicals.

Enteric viruses were detected in the AWT effuents only once during the three-year study, but were generally present in influent waters. Mutagenic activity as determined by the Ames test was detected frequently in concentrates prepared from influent water and from water taken at points following chlorination. This activity was reduced by GAC treatment. The cause of mutagenic activity could not be determined from organic chemical analysis of extracts. Alkylphenol polyethoxy carboxylates that became brominated during chlorination at WF21 were among the most prevalent organic materials generally found present in the mutagenic extracts.

Lime, GAC, and RO treatments were most effective in removing organics as determined by the collective parameters of chemical oxygen demand (COD) and total organic carbon (TOC). Air stripping was highly effective in the removal of a range of volatile organic compounds including one to three carbon halogenated organics such as the trihalomethanes and organic solvents, chlorinated benzenes, and aromatic hydrocarbons. GAC treatment was effective in removing some of the less volatile organics. Heavy metal removal occurred primarily through lime treatment, and general inorganic removal by RO treatment. No individual process was satisfactory for removing the range of organic and inorganic materials present in secondary effluent; a series of processes such as at WF21 is required. An evaluation was made of the potential of various indicator compounds and collective parameters to serve as surrogates to indicate the efficiency of contaminant removal by individual processes and the overall treatment systems.

At the beginning of this study, operation of the AWT plant was discontinued for about three months to repair the lining in the final chlorination basin. During another similar period, operation was discontinued so that a hydrogeological study of the groundwater basin could be conducted. Outside of these two major periods of shutdown, the AWT plant at WF21 was operated about 88 percent of the time, and the AWT plus RO plant about 89 percent of the time. About 5 percent of the time, the overall plant was not operated because of planned shutdowns for routine maintenance. About 7 percent of the time the plant was stopped for equipment repairs. Since there is no need for continuous production of water, WF21 can be shutdown as needed.

Increased rainfall in the Orange County area during the study period caused the groundwater elevation to rise, thus reducing the need for groundwater injection. For this reason, WF21 was not generally operated at design capacity. Costs for treatment per unit volume of water produced were determined for the last year of this study, and were projected for operation at design loading with a 90 percent availability factor. The estimated cost for operation and maintenance was $\$0.20/m^3$ for AWT treatment alone and $\$0.42/m^3$ for AWT plus RO treatment.

This report was submitted in partial fulfillment of Cooperative Agreement No. CS 806736 by the Orange County Water District under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period October 1, 1979 to April 1, 1982 and was completed August 15, 1982.

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SECTION 1

INTRODUCTION

Water Factory 21 (WF21) is a 0.66 m^3/s (15 mgd) advanced wastewater treatment plant constructed by the Orange County Water District (OCWD) to improve the quality of biologically treated municipal wastewater so that it can be used to provide the injection water needed to reduce seawater intrusion into the groundwater supply. Because of the growing water shortage, there has been an increased interest in wastewater reclamation to help satisfy agricultural, industrial, and municipal water needs. The operation of WF21 provided an opportunity to obtain information on the efficiency and reliability of some of the most advanced treatment processes currently available under full-scale operation for removal of a variety of contaminants of public health concern, and for this reason, the study reported herein was instigated.

This is the third and final in a series of reports (1,2) describing the overall performance of WF21 from the time operation began in October 1976 through March 1981. This report overlaps partially with the second one written in January 1980 (2) and covers the period from March 1978 through March 1981, or a period of three years. During this time, the influent to WF21 was an activated sludge treated municipal wastewater, while prior to that time it was a less-well treated trickling filter effluent, both provided by the County Sanitation Districts of Orange County (CSDOC).

The processes included at WF21 are high-lime treatment for suspended solids, heavy metals, and organics removal; air stripping for ammonia and volatile organics removal; recarbonation for pH adjustment; chlorination for algae control; filtration and activated-carbon adsorption for organics and additional suspended solids removal; reverse osmosis for demineralization and organics removal, and final chlorination for disinfection and partial ammonia removal.

During the three years covered by this report, the efficiency and reliability of WF21 were evaluated for removal of a variety of inorganic constituents, including heavy metals, many individual organic compounds, a series of collective parameters, and biological forms including bacteria and virus. Analyses were intensified during the last nine months of operation, and more detailed organic characterizations were then made. In addition, organic concentrates were obtained for toxicological testing using the Ames mutagenic assay. A summary of the overall results for the three-year period and for the more intense nine-month period are contained in this report.

SECTION 2

CONCLUSIONS

1. During this study, reclaimed water from WF21 both with and without reverse osmosis (RO) treatment, met EPA interim primary drinking water regulations more than 95 percent of the time (except for coliforms in the unchlorinated RO effluent). Since no comprehensive standards and criteria currently exist to define potable water regardless of source, none of the above should be construed to mean that the described product water was potable.

2. Reclaimed water without RO treatment met most EPA secondary drinking water criteria except for pH, and general mineral parameters such as total dissolved solids (TDS), chlorides, and sulfates. With RO treatment all secondary criteria were met. These conclusions apply to all secondary standards except odor and corrosivity, which were not measured.

3. The effluent from WF21, even without RO treatment, met on the average most of the health criteria at the 10^{-6} life-time risk level developed for those priority pollutants not currently covered by EPA primary or secondary regulations and for which the limits are above the analytical detection limit of the procedures used. No judgments can be made for compounds for which criteria are below the analytical detection limit of 10 to 100 ng/l, nor for those priority pollutants that could not be quantified by the procedures used. Also, the list of priority pollutants does not include all potentially toxic chemicals.

4. Mutagenic activity as determined by the Ames test was detected frequently in WF21 influent samples and after points of chlorination. This activity was reduced by activated carbon treatment, but recreated on terminal chlorination following carbon treatment.

5. Brominated alkylphenol polyethoxy carboxylates were tentatively identified in reclaimed wastewater. Bromination appeared to occur during chlorination. These compounds were among the major compounds present in the mutagenic organic fractions following chlorination of WF21 effluent.

6. Mutagenic activity was reduced when metabolic activators were included in the test. The mutagenic compounds appeared to be associated with hydrophobic organic acids.

7. Enteric viruses were detected in the effluents in only one case during this phase of study, although they generally were present in the influent.

8. Within the limits of this study, no evidence was found that would indicate that this reclaimed municipal wastewater would pose a significant health risk if used as a source of municipal water supply. However, detailed toxicological testing generally considered necessary to draw valid conclusions in this respect have not been conducted.

9. Ultraviolet absorption was not found to be a satisfactory surrogate for monitoring organic material during treatment, partly because of a significant positive chlorine interference and partly because of lack of good statistical correlation with total organic carbon (TOC) or any other organic chemicals measured.

10. TOC or chemical oxygen demand (COD) are good surrogates at WF21 for monitoring the performance of granular activated carbon (GAC columns) in removing the trace organic compounds studied.

11. Barium and manganese are promising indicator chemicals for monitoring the range of trace heavy metal removal by lime treatment.

12. Promising indicator chemicals for monitoring the range of removals by air stripping are 1,1,1-trichloroethane, tetrachloroethylene, and 1,2- and 1,4-dichlorobenzenes.

13. During the 3-year period of this study, the treatment plant through final chlorination was operated 74 percent of the time. Of the 26 percent of time when the plant was shutdown, 7.4 percent was for chlorine basin repair, 7.8 percent was a planned shutdown to conduct a hydrogeological study of the groundwater basin, 5.1 percent was for planned general maintenance, 1.6 percent was due to external causes, and 5.5 percent was due to other equipment failures, repairs, or modifications.

14. The treatment plant through RO treatment (which was not affected by final chlorination basin repairs nor the hydrogeological study) was operated 89 percent of the time during this study. About one-half of the 11 percent down-time was for planned treatment plant maintenance and the other one-half was due to external causes and equipment failures, repairs, or modifications.

15. The total cost for producing blended water for groundwater injection at WF21 during the 1980-81 year was $\$0.43/m^3$, of which 64 percent was for operation and maintenance and the remainder for capital depreciation. Costs are increased because the plant was not operated at design flows during this period.

16. Projected costs per m^3 of treated water assuming operation at design flow with 90 percent plant availabliity factor are \$0.20 for advanced treatment without reverse osmosis, \$0.22 additional cost for RO treatment, \$0.22 for blended water including deep-well water, and \$0.30 for blended advanced treated water without deep-well water.

SECTION 3

RECOMMENDATIONS

1. Toxicity testing including both a short term battery of tests and long term animal tests should be conducted to further evaluate the relative safety of reclaimed wastewater as a source of drinking water supply.

2. Evaluations similar to those reported here plus the above recommended toxicity testing should be conducted on typical conventional water supplies throughout the country in order to develop a comparative evaluation of the health risks associated with drinking waters.

3. Compounds causing mutagenic response in the Ames test following chlorination of reclaimed wastewater should be identified so that their health risks can be better evaluated.

4. The environmental significance of alkylphenol polyethoxy carboxylates that appeared to become brominated upon chlorination as found in this study should be evaluated.

5. Research should continue to develop qualitative and quantitative information on the organic residues in reclaimed water.

SECTION 4

WATER FACTORY 21 PROCESS DESCRIPTION

GENERAL DESCRIPTION

Water Factory 21's advanced wastewater reclamation facilities were designed to treat 0.66 m^3/s (15 mgd) of unchlorinated secondary effluent from municipal wastewater treatment by the processes indicated in Figure 1. These processes include lime clarification with sludge recalcining, air stripping, recarbonation, prechlorination, mixed-media filtration, granular activated carbon (GAC) adsorption with carbon regeneration, final chlorination and reverse osmosis (RO) demineralization. Also indicated in Figure 1 are the sample locations, designated as Q1, Q2, etc. Detailed design criteria for each process are contained in Appendices A and B. All unit processes were designed as dual or parallel units, and operation of most unit processes was at or near design capacity during the total study period. Following is a general description of each process.

The plant was designed to meet water quality requirements for injection set by the Regional Water Quality Control Board and the California Department of Public Health. These requirements pertain primarily to the blended water which also can and does include water pumped from a deep well. The requirements also apply mostly to inorganic constituents including heavy metals, but other contaminants such as coliforms, chemical oxygen demand (COD), and turbidity are included. The specific requirements together with the reliability of WF21 in meeting these requirements are discussed in Section 11 of this report.

PROCESS DESCRIPTION

Chemical Clarification

Chemical clarification is accomplished in separate rapid mix, flocculation, and sedimentation basins. Lime is used as the primary coagulant and is added in slurry form to the rapid mix basin. Lime feed is automatically controlled to achieve an optimum pH of 11.0. A lime dose of 300-500 mg/l as calcium oxide was generally added to maintain this pH level. The three-stage flocculation basins are operated with G values of 100, 25, and 20 s^{-1} in the first, second, and third basins, respectively. Detention time is approximately 10 minutes in each compartment at design flow. An anionic polymer (Allied Colloid LT-26) dose of approximately 0.1 mg/l is used as a settling aid in the third-stage basin. The water flows from the bottom of this basin to the settling basin, which is equipped with inclined settling tubes to improve

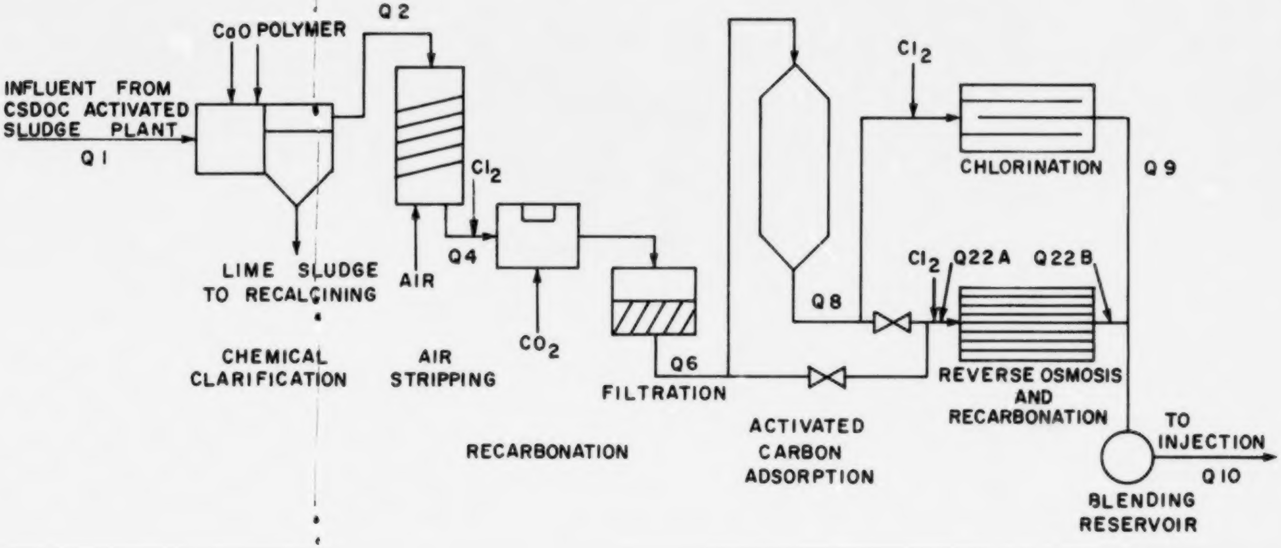

INFLUENT FROM CSDOC ACTIVATED SLUDGE PLANT
Q 1
CaO POLYMER
Q 2
LIME SLUDGE TO RECALCINING
CHEMICAL CLARIFICATION
Cl2
Q4
AIR
AIR STRIPPING
CO2
RECARBONATION
Q6
FILTRATION
Q8
ACTIVATED CARBON ADSORPTION
Cl2
CHLORINATION
Q 9
Cl2
Q22 A
Q22 B
REVERSE OSMOSIS AND RECARBONATION
TO INJECTION
Q 10
BLENDING RESERVOIR

Figure 1. Flow schematic diagram and sampling locations for Water Factory 21.

clarification. Results of lime clarification have shown this process to be effective in reducing turbidity, phosphates, organics, heavy metals, and suspended solids.

Air Stripping

Following settling, air stripping is accomplished in counter-current induced-draft towers with a design air to water ratio of 3000 m^3/m^3. Originally the towers were operated to strip ammonia from the secondary municipal effluent. However, changes in influent water quality characteristics, WF21's method of operation, and regulations for ammonia concentrations in the injection water made it unnecessary to remove ammonia with the stripping towers. Thus the tower fans were turned off in April 1978 and subsequently the towers were only used with natural ventilation for removal of volatile organics only. The water from the chemical clarifier is pumped to the top of the stripping towers, where it is allowed to cascade over polypropylene splash-bar packing 7.6 m high. While little ammonia removal is experienced through the towers, this process was shown to be effective for removing volatile organic compounds.

Recarbonation

Following air stripping, the pH of the treated wastewater is adjusted in the recarbonation basins. Carbon dioxide from lime recalcining is added in single stage to lower the pH to approximately 7.5. The recarbonation basins also serve as chlorine contact chambers. Generally 10 to 20 mg/l of chlorine was added during the three-year study period reported here, for partial disinfection and algae control.

Mixed-Media Filtration

The recarbonated effluent passes through open gravity, mixed-media filter basins designed for a hydraulic loading rate of 0.2 $m^3/m^2/min$. The filter media, 0.76 m deep, consist of layers of coarse coal, silica sand, and garnet, supported by a layer of silica and garnet gravel with a Leopold underdrain.

Granular Activated-Carbon Adsorption

The water is then pumped to the top of the seventeen downflow GAC contactors which contain Calgon Filtrasorb 300 activated carbon. The contactors operate in parallel, each having an empty-bed contact time of 34 minutes. The hydraulic loading rate for each column is 0.2 $m^3/m^2/min$. Following GAC adsorption, the flow is presently divided. When following the original design, two-thirds goes to the final chlorination basin for post-chlorination, followed by 30 minutes of contact time at design flow. The other one-third is diverted to the 0.22 m^3/s RO plant which removes dissolved solids from the reclaimed wastewater. Concurrent with the beginning of this study, above average rainfall increased the Orange County groundwater table and reduced the need for injection water. In response OCWD elected to operate only a portion of the AWT side of the plant, which reduced operating expenses. This decision however did not interfere with the objectives of this study. Because the carbon columns are multiple parallel units, three columns were selected for the AWT stream and used, one at a time, throughout the study period. This allowed the system to be operated at design flow and at the same time provided an opportunity to regenerate the carbon for the AWT system more frequently, which was desirable.

Reverse Osmosis

A flow diagram of the full-scale RO plant is shown in Figure 2. Included in this process are feeding of sodium hexametaphosphate as a scale-precipitation inhibitor, addition of chlorine to control biological growth within the membrane modules, and 25 micron filters to remove particulates. The water is then pressurized by vertical turbine feed pumps to a total dynamic head of 420 m water. H_2SO_4 is injected into the high-pressure feed header to adjust pH to approximately 5.5 before the water is applied to the RO membranes. The RO plant is designed to provide 90 percent salt removal while achieving 85 percent overall water recovery. The demineralized water receives post-treatment in two packed-tower decarbonators to air-strip the dissolved carbon dioxide which results from pH adjustment to 5.5. These decarbonators have been found to be efficient in removing volatile trace organics. Sampling location Q22B is located after the decarbonators, thus chemical changes between Q22A and Q22B reflect the combined effect of RO treatment and decarbonation. A detailed description of the RO plant's design criteria is provided in Appendix B.

Final Chlorination

Following GAC treatment, a portion of the wastewater flow is sent to the chlorine contact basin for final chlorination. Under design conditions, two-thirds of the treated water or 0.44 m^3/s would pass through this treatment process. This would result in a detention time of about 45 min. in the single basin used. However, for much of the period during this study, the flow was reduced below this amount as described in Section 7 of this report. The concentration of chlorine applied during the first two years of the study reported here varied between 15 and 25 mg/l. At this time the concentration of ammonia in the influent waters to WF21 was quite low due to prior nitrification. However, during the last year, the nitrification was stopped and so high concentrations of ammonia were present in influent water. In order to reduce the ammonia in the injection water to acceptable levels, the chlorine dosage was increased to levels between 45 and 140 mg/l. This did not result in complete breakpoint chlorination, but did result in significant reductions in ammonia concentration.

RECLAMATION PLANTS FOR EVALUATION

At WF21 all water was processed through GAC treatment. Then a portion was chlorinated for final disinfection and the remaining portion was given RO treatment. The chlorinated and RO treated waters were then blended together with water from a deep aquifer well to produce the water used for groundwater

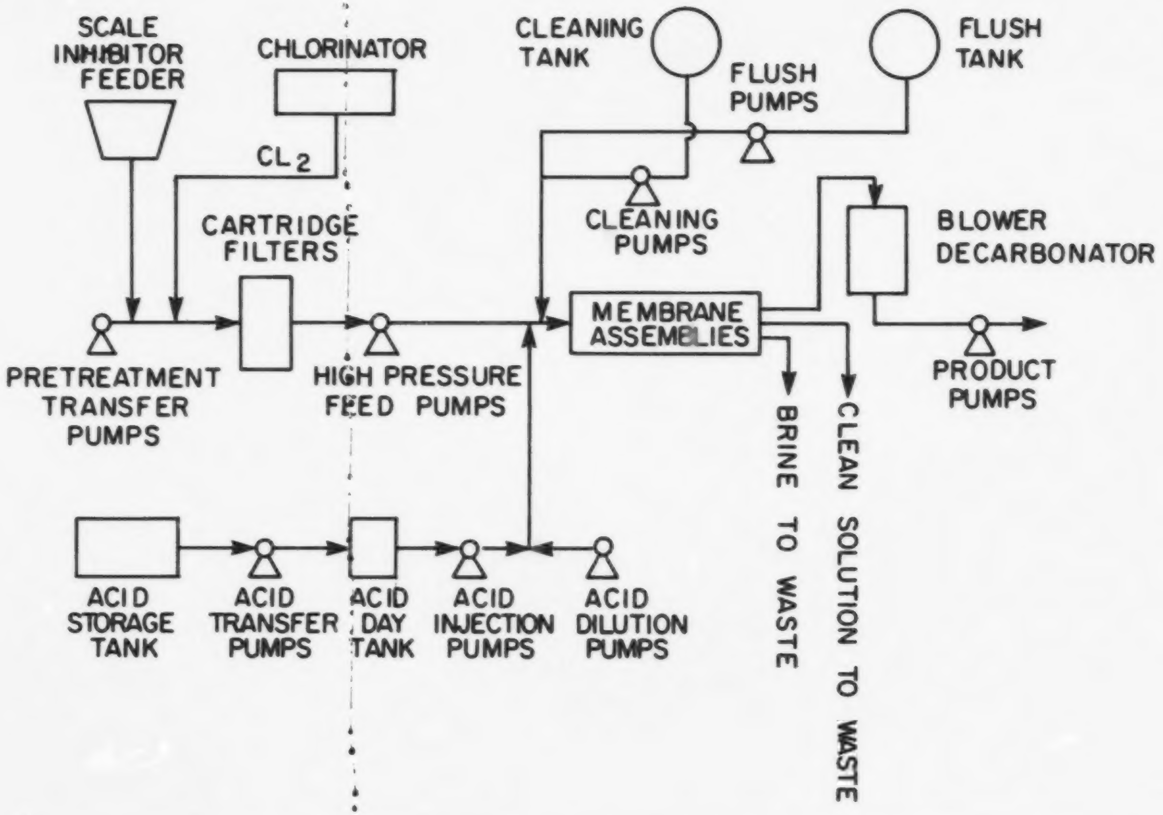

SCALE INHIBITOR FEEDER
CHLORINATOR
CL$_2$
CARTRIDGE FILTERS
PRETREATMENT TRANSFER PUMPS
HIGH PRESSURE FEED PUMPS
CLEANING TANK
FLUSH PUMPS
FLUSH TANK
CLEANING PUMPS
MEMBRANE ASSEMBLIES
BLOWER DECARBONATOR
PRODUCT PUMPS
BRINE TO WASTE
CLEAN SOLUTION TO WASTE
ACID STORAGE TANK
ACID TRANSFER PUMPS
ACID DAY TANK
ACID INJECTION PUMPS
ACID DILUTION PUMPS

Figure 2. RO Schematic.

injection. For the purpose of this study, however, WF21 was considered to consist of two reclamation plants: one termed the "AWT plant" included all processes through final chlorination (no RO treatment), and the other included all process through RO treatment (no final chlorination). The GAC columnsfeeding the RO system were different from the GAC columns feeding the final chlorination tanks. Therefore, the quality of Q8 water (final chlorination influent) would be somewhat different from that of Q22B (RO influent).

RO treatment is relatively expensive and generally considered for use only when high mineral content of the water is a problem. It was thought that by providing data on essentially two treatment systems, one with and the other without RO treatment, that information of value for assessing the capabilities and reliability of plants for reclaiming wastewater could be obtained.

PROCESS LOADINGS

The loadings to the various processes varied from the design values during this study. Details on the actual variations are given in Section 7 on Plant Operations and Performance.

SECTION 5

SAMPLING AND ANALYTICAL PROCEDURES

SAMPLING

Grab and composite samples were stored under refrigeration prior to organic and inorganic analyses. Composite samples were prepared by mixing equal volumes of eight grab samples taken manually at three-hour intervals over a 24-hour period. Analyses for chemical oxygen demand (COD), total organic carbon (TOC), inorganic constituents, and heavy metals were conducted on daily composite samples by the WF21 analytical laboratory. Viral analyses were conducted by James Montgomery Engineers, Pasadena, California. Specific organic constituents and several nonstandard collective organic parameters were analyzed by the Stanford Water Quality Control Research Laboratory. Samples analyzed at Stanford were shipped by air in insulated containers, and arrived on the same day. Specific methods used in sample preservation prior to analysis are given under the specific analytical procedures which follow. Sampling locations are designated by numbers preceded by the letter Q in Figure 1. For most constituents samples were taken once every seven days prior to January 1980 and every 6 days after that time. This change resulted in samples being collected on different days of the the week, thus leveling out weekly variations in concentrations.

GENERAL INORGANICS AND TRACE ELEMENTS

In general fewer samples were taken for general inorganic and trace elements analyses prior to January 1980 than after that time as noted in Table 1. During the latter period, the contract associated with this report was started and then sampling for both inorganic and organic constitutents was intensified. All analyses were conducted in accordance with Standard Methods (7). Table 2 summarizes the particular procedures from Standard Methods used for each parameter.

ORGANIC SUBSTANCES

Collective Parameters

The collective parameters included COD, and total organic nitrogen (TON). These analyses were conducted in accordance with procedures outlined in Standard Methods (7). In addition, analyses were conducted for TOC, ultraviolet absorbance (UVA), total organic halogen (TOX), and total trihalomethane forming potential (TTHMFP). Analytical methods used for the latter analyses are not standard and so are described in more detail below. Collective

TABLE 1. WATER FACTORY 21 SAMPLING SCHEDULE FOR GENERAL PARAMETERS AND TRACE ELEMENTS

	Sample Points								
Parameter	Plant Influent Q1	Clarifier Effluent Q2	Air Stripping Effluent Q4	Filter Effluent Q6	GAC Effluent Q8	Chlorine Contact Basin Effluent Q9	Blended Water Q10	RO Plant Influent Q22A	RO Plant Effluent Q22B
pH	DC	2G	2G[3]	2G[3]	2G[3]	DC	DC[3]	DC[4]	DC[3]
EC	CA	CA		CA[3]	CA	CA	DG	DG	
TDS	WC	WC[3]	WC	BC[3]	BC[3]	WC	WC	WC	WC
Turbidity	CA	CA		CA		CA			
NH_3-N	WC	WC	WC	BC[3]	WC[3]	WC	DG		WC
NO_3-N	WG	WG[3]	WC	BG[3]	WC[3]	WG	WG	WG	WG
Total & Free Chlorine Res.				DG		2G			WG[3]
TOC				DC	WC				
COD	DC	DC		DC	DC		DC	DC	DC
MBAS	WC	WC	WC	BC[3]	WC	WC	WC		WC[3]
Phenol	WG	WG	WC	BC	WG		WG	BC	WC
Cyanide	WG	WG[3]	WG	BC[3]	MG[3]	WG	WG		WG[3]
Trace Elements[1]	WC[3]	BC[3]		BC[3]	BC[3]	WC[3]	WC	MC[3]	WC[3]
Calcium	DC[4]	DC[3]	DC[3]	DC[3]		DC[4]	DC[3]		DC[3]
Magnesium	WC	WC[3]	WC	BC[3]	BC[3]	WC	WC		WC[3]
Total Hardness	WC	WC[3]	WC	BC[3]	BC[3]	WC	WC	WC	WC
Sodium	WC	WC[3]	WC	BC[3]	BC[3]	WC	WC	DC	DC
Potassium	WC[3]	WC[3]	WC	BC[3]		WC[3]			WC[3]
Sulfate	DC[4]	DC[3]	DC[3]	DC[3]		DC[3]	DC[3]	DC	DC
Chloride	DC[4]	DC[3]	DC[3]	DC[3]		DC[3]	DC[3]	DC	DC
PO_4-P	WC	WC	WC	BC[3]				WC[3]	WC[3]
TKN		WC	WC	BC[3]		WC	DG		WC[3]
ORG-N	WC	WC	WC	BC[3]	WC[3]	WC	DG		
Fluoride	WC	WC		WC[3]	WC[3]	WC	WC		WC[3]
Boron	WC	WC[3]	WC	BC[3]	BC[3]	WC	WC		WC[3]
Coliform	WG	WG		DG	DG	DG	DG	DG[3]	DG[3]
Virus[2]	DG					DG			DG
Color	WC	WC[3]		WC[3]	WC[3]	WC	WC		WC[3]

[1] Trace elements include: arsenic, chromium (VI), barium, copper, mercury, selenium, cadmium, silver,lead, zinc, iron, and manganese.

[2] Sampling and concentration on-site by OCWD, analysis by Montgomery Engineers.

[3] Not sampled or sampled infrequently prior to January 1980.

DC - daily composite (1 grab every 4 hr. 500-ml sample); DG - daily grab sample; 2G - one grab every 2 hr. (day-shift only); GM - once per month grab; WC - 24 hr composite taken once per week prior to January 1980 and 6 day intervals after that. CA - control panel value - online instrument average; WG - grab sample once per week; BC - 24 hour composite taken twice per month.

[4] Daily composite once per week prior to January 1980.

TABLE 2. GENERAL ANALYTICAL PROCEDURES

Parameter	Method	Page Number from Standard Methods (7), 14th Edition
conductivity @ 25°C	direct specific conductance meter	71
pH	direct, pH meter	460
total dissolved solids (TDS)	glass fiber filtration, water bath (100°C) and oven drying (180°C)	92
calcium	titration with EDTA	189
magnesium	atomic absorption, flame	148
sodium	atomic absorption, flame	250
potassium	atomic absorption, flame	234
aluminum	atomic absorption, graphite furnace	148
iron	atomic absorption, graphite furnace	148
manganese	atomic absorption,.graphite furnace	148
silver	atomic absorption, graphite furnace	148
arsenic	atomic absorption, graphite furnace	148
barium	atomic absorption, graphite furnace	148
cadmium	atomic absorption, graphite furnace	148
chromium	atomic absorption, graphite furnace	148
copper	atomic absorption, graphite furnace	148
lead	atomic absorption, graphite furnace	148
selenium	atomic absorption, graphite furnace	148
zinc	atomic absorption, graphite furnace	148
mercury	flameless atomic absorption	156
alkalinity	as $CaCO_3$, titration with H_2SO_4	278
chloride	titration with $Hg(NO_3)_2$	304
fluoride	specific ion electrode	391
sulfate	turbidimetric	496
phosphate	ascorbic acid	481
nitrate-nitrogen	brucine sulfate	427
ammonia-nitrogen	1. Kjeldahl method	438
	2. phenate method	416
organic-nitrogen	Kjeldahl	437
boron	curcumin	287
methylene blue active substance (MBAS)	methylene blue	600
chemical oxygen demand (COD)	dichromate digestion	550
silica	molybdosilicate	487
hardness, total	EDTA	202
phenol	colorimetric	582
dissolved oxygen	iodometric, azide modification	443
dissolved sulfide	methylene blue	503
coliform	membrane filter	928
fecal coliform	membrane filter	937
color	visual comparison	64
cyanide	distillation and colorimetric	361

organic parameters were determined with composite samples except for TTHMFP for which grab samples were used. The sampling schedule is outlined in Table 1.

Total Organic Carbon

TOC was determined at Stanford with an Envirotech Dorman DC-80 instrument and at OCWD with a Barnstead TOC analyzer according to procedures recommended by the manufacturers.

Ultraviolet Absorption Analysis

Samples were filtered with a 0.45 μm Millipore filter. UV absorption was measured at a wave length of 254 nm on a Bausch & Loumb spectrometer model 600 using quartz cuvettes with a pathlength of 10 mm. Measurements were relative to "pure" Milli-Q water produced by a purification system (Millipore Corp., Bedford, Mass.).

Trihalomethanes Formation Potential (TTHMFP)

For TTHMFP 60 ml samples in sealed hypovials were used. Initially (August 1979), samples were spiked with 30 mg/l chlorine, the reaction temperature was 20 ^{o}C and the time was 48 hr. The pH of the sample was adjusted to 8 with phosphate buffer and 6N NaOH if necessary. Chlorine was added as an aqueous solution which was prepared by bubbling chlorine gas through Milli-Q water. After 48 hrs, the spiked solution was quenched with a sodium thiosulfate solution. The samples were collected as for regular volatile organic analysis (VOA) samples described below. TTHMFP as measured here represents the sum of trihalomethanes present at the start of the TTHMFP test and those formed during the test. This is sometimes called terminal trihalomethanes rather than the TTHMFP.

As of December 24, 1979, WF21 was receiving secondary effluent containing higher ammonia concentrations. Therefore, chlorine doses were increased to 50 mg/l, but since this appeared to be insufficient to achieve breakpoint chlorination, it was further increased to 300 mg/l beginning 5/1/80. The reaction time was extended to 7 days. During the 7 days reaction time, gas bubbles formed which might have led to unquantifiable losses of volatile organics. To minimize this problem the samples were stored under water with the seals pointing downwards, which has proven by experience to minimize gaseous losses. The trihalomethanes found were analyzed using the regular VOA procedure and adding 40 μg/l internal standard. The variation in procedures used made good interpretation of results difficult, as did the poor precision for the TTHMFP analysis.

Total Organic Halogen

TOX was determined by procedures as described by Chow and Roberts (8). Organic compounds contained in samples were adsorbed onto activated carbon, the activated carbon was pyrolyzed to convert organic halogens to inorganic halides, and microcoulometer titration was used to quantify the halide concentration. In the latter steps, a Dohrmann-Envirotech C-300 microcoulometer and a Dohrmann-Environtech C-300-S titration cell were used. Samples for TOX analysis were collected in 120 ml hypovials (Pierce Chem. Co., Rockford, IL 61105) containing 1.0 ml of 0.1N sodium thiosulfate solution to dispel residual chlorine. The filled hypovials were sealed with Teflon® lined septas, (Pierce Chemical Co.) and stored at 4°C until analyzed. Carbon blanks were also always run, but background chloride on the carbon was not significant. The standard deviation for TOX analysis was 30 μg/l.

Specific Organic Compounds

The general scheme followed for the analysis of specific organic compounds is depicted in Figure 3.

Five different analytical procedures were employed to analyze for specific organics as summarized in Table 3. Of prime concern were compounds listed by the U.S. Environmental Protection Agency as priority pollutants and indicators of industrial pollution (9), but efforts were made to include other specific compounds as well which could be used to evaluate plant performance. The most significant extension was achieved by the inclusion of a methylation step, which permitted the analysis of nonvolatile organic acids.

Materials

Hexane, methylene chloride ($MeCl_2$) and ether were used as received ("distilled in glass", Burdick and Jackson Laboratories, Inc., Muskegon, MI 49442). Pentane ("distilled in glass," Burdick and Jackson) was further purified by passing through a 30 cm x 2 cm column packed with alumina basic, activity grade I (ICN Pharmaceuticals, Inc., Cleveland, Ohio 44128). Carbon disulfide (CS_2) was used as received (gold label, Aldrich, Milwaukee, Wis. 53233). Anhydrous sodium sulfate (J. T. Baker, Philipsburg, M. J. 08865) was purified by heating at 600°C overnight, washing with hexane and drying on arotoevaporator under reduced vacuum at 60° C. Florisil (60/100 mesh), activated by the manufacturer (Floridin Comp., Pittsburgh, Penn. 15222) was reactivated at 130°C prior to use. Standard solutions of priority pollutants were purchased from Supelco, Inc., Bellefonte, PA 16823. Surrogate standard compounds used for the various methods are summarized in Table 3. Compounds selected for surrogate standards were ones that provided a good detector response, had good recovery efficiencies by the concentration methods used, and had elution times similar to that of compounds being analyzed but peaks did not overlap with the compounds of interest. Appendix G provides a comparison of recovery efficiencies of surrogate standards with those of compounds of interest to this study. Standards were used without further purification. Samples and extracts were stored in bottles and vials lined with Teflon®. All glassware was cleaned by sequentially rinsing with tap water, chromic acid solution, Milli-Q water and acetone. After washing, the glassware was heated to 130° C overnight.

Diazomethane

Diazomethane for methylation was produced from DIAZALD® (N-methyl-N-nitroso-p-toluenesulfonamide, Aldrich Chemical Co.) by the following procedure.

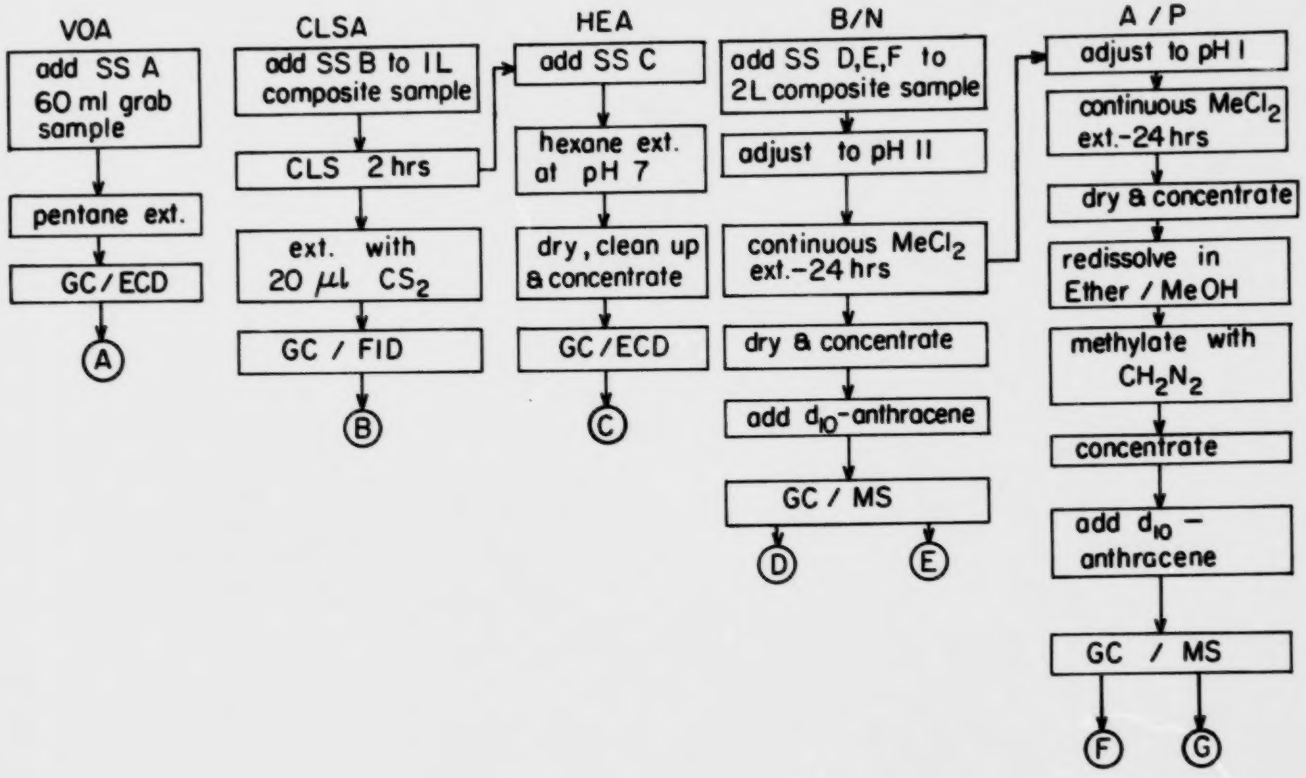

VOA
add SS A 60 ml grab sample
pentane ext.
GC/ECD
A
CLSA
add SS B to 1L composite sample
CLS 2 hrs
ext. with 20 µl CS2
GC / FID
B
HEA
add SS C
hexane ext. at pH 7
dry, clean up & concentrate
GC/ECD
C
B/N
add SS D,E,F to 2L composite sample
adjust to pH 11
continuous MeCl2 ext.-24 hrs
dry & concentrate
add d10-anthracene
GC / MS
D
E
A / P
adjust to pH 1
continuous MeCl2 ext.-24 hrs
dry & concentrate
redissolve in Ether / MeOH
methylate with CH2N2
concentrate
add d10 - anthracene
GC / MS
F
G

Figure 3. General analytical scheme for analysis of specific organic compounds. The compounds quantified are listed in Table 3.

TABLE 3. SUMMARY OF PROCEDURES, COMPOUNDS ANALYZED, AND SURROGATE STANDARDS

Group	Procedure	Compounds	Surrogate Standard Compound	Supplier*	Standard Solution	
					Solvent	Conc. μg/ l
A	VOA	haloforms, 1- and 2-carbon halogenated solvents	1,2-dibromoethane	M	pentane	0.02
B	CLSA	aromatic hydrocarbons	1-chlorododecane (Cl-C_8) 1-chlorooctane (Cl-C_{12}) 1-chlorohexadecane (Cl-C_{16})	E E E	acetone	0.05
C	HEA	chlorinated hydrocarbon, pesticides, polychlorinated biphenyls chlorinated anisoles	hexabromobenzene	A	methanol	0.025
D,E	B/N	polynuclear aromatic hydrocarbons	3,6-dimethylphenanthrene	AN	acetone	10
F	A/P	phenolic compounds	p-bromophenol	A	methanol	1
G	A/P	nonvolatile organic acids	d_{10}-anthracene	S	methylene chloride	2

*Suppliers: M = MC/B, Norwood, OH 45212; E = Eastman, Rochester, NY 14650; A = Aldrich, Milwaukee, WI 53201, AN = Analabs, Inc., New Haven, CT 06473; S = Supelco, Bellefonte, PA 16823.

An apparatus for downward distillation was constructed from a DIAZALD KIT according to the configuration suggested by Aldrich. Approximately 2.15 g (10 mmoles) of DIAZALD were transferred to the 250 ml round flask along with a magnetic stirring bar, followed by the addition of 30 ml of ethyl ether. As the flask was cooled in an icewater bath, the DIAZALD was stirred into solution, and 13.0 ml of a 0.81N solution of potassium hydroxide in 95% ethanol was slowly added. Upon completion of the addition, the flask was allowed to warm to room temperature, and the ethereal-alcoholic diazomethane solution was slowly distilled into the dry ice-cooled receiving flask.

Extractions and Chromatographic Analysis

Volatile Organic Analysis (VOA)--

The procedure to analyze highly volatile organics was adopted from Henderson, Peyton, and Glaze (10). The 50-ml samples were collected and shipped in head-space-free sealed vials (Pierce Chemical Company, Rockford, IL, 61105) and extracted in the same bottles after replacing 1 ml of the water by 1 ml of pentane. As a surrogate standard 1,2-dibromomethane was added. Five µl of the extract were injected onto a 2 m x 4 mm i.d. column packed with 10% squalane on chromosorb W/AW (80-100 mesh) at 67°C. Argon/methane was used for a carrier gas and a linearized ^{63}Ni detector (Tracor, Austin, Texas 78721) with a Sigma 10 reporting integrator (Perkin-Elmer, Norwalk, CT 06856) was used for detection and quantitation.

Closed-Loop Stripping Analysis (CLSA) --

The closed-loop stripping analysis was adapted from Grob and co-workers (7,8). Gas-washing bottles, (100-, 250-, 500-, and 1000- ml) were modified so that they could be connected to an all-steel pump (Metal Bellows, Sharon, Mass. 02067). After placing the sample in the bottle and adding appropriate amounts of 1-chloroalkanes as internal standards an activated carbon (AC) filter was placed in the filter holder and the headspace was purged by running the pump for 30 seconds to remove contaminants in the headspace air. Following this, a clean AC filter was placed in the filter holder and continuous air circulation (1.5 l/min) was started. After two hours the AC filter was extracted with three 7-µl portions of carbon disulfide, approximately 14 µl of which could be recovered. Of this extract, 1.5 µl was then injected splitless (11) for 42 seconds onto a 50-m UCON HB column (Jaeggi GC Laboratory, Trogen, Switzerland) mounted in a Carlo Erba Fractovap 2150 GC (E.M. Becker Co., Bala Cynwyd, PA, 19004). After a 4 min isothermal phase at 40°C, the temperature was raised to 180°C at 3°C per min. The compound 1-chloro-n-dodecane (Cl-C_{12}) was used as a surrogate standard for quantitation. The signal from the flame-ionization detector was recorded by a reporting integrator (Perkin-Elmer model Sigma 10).

Hexane Extraction Analysis (HEA) --

One-liter samples were extracted in 2-liter separatory funnels with two 15 ml portions of 85/15 v/v hexane/ether. Hexabromobenzene was added as a surrogate parameter. The two phases were separated after allowing the extracted sample to stand for a minumum of 2 hours. The two extracts were then combined and dried over sodium sulfate. After concentration to one ml with a gentle nitrogen stream, the extracts were chromatographed on a small florisil column (10). Chlorinated hydrocarbon pesticides, PCBs, and similar compounds were eluted with 10 ml hexane/ether (85/15 v/v) and reconcentrated to 1 ml or less. The concentrated extract was analyzed on a 50-m SE 52 fused silica capillary column, which was mounted in a GC (Finnigan 9610) equipped with a Grob injector (E. M. Becker Co., Bala Cynwyd, PA) and a wide-range electroncapture detector (Valco Instruments, Houston, TX 77055). Samples from sufficiently clean water supplies (all but Q1 samples) did not require pre-separation on florisil and were analyzed directly after drying and concentration of the combined hexane extracts.

Aliquots of 1.5-2.0 µl were injected splitless for 42 seconds onto the 90°C column. After a 1-min isothermal phase, the temperature was raised at 3°C/min to 230°C and held at this temperature for four minutes. The injector temperature was held at 220°C and the detector temperature was set at 250°C. Helium was used as carrier gas with the column inlet pressure adjusted to 1 atm. Scavenger gas was introduced into the detector by means of a heat exchanger, fabricated with 1/8" stainless steel tubing and a SWAGELOCK fitting. The end of the fused silica column was inserted all the way through the heat exchanger and into the detector cell. The ECD signal was recorded and quantified electronically using a model 4000 integrator (Spectra Physics, Santa Clara, CA 95051).

Continuous Liquid-Liquid Extractions (CLLE) --

Bases/Neutrals (B/N) -- Two-liter composite samples were extracted using a continuous liquid-liquid extractor (Continental Glass Blowing Corporation, Richland, NY 08350). The continuous extractors (CE) was equipped with 1000 ml round flasks and water-cooled condensors. $MeCl_2$ (325 ml) was placed in the flasks along with boiling chips. Approximately 100 ml $MeCl_2$ were added to the CES. After adding the 2-liter samples to the extractor, the bottles were rinsed with $MeCl_2$. The rinse was added to the extractor. The pH was adjusted to 11 with a 6N sodium hydroxide solution and checked with pH paper. 3,6-dimethlyphenanthrene (DMP) was added as a surrogate standard. $MeCl_2$ was recirculated for 24 hours at a rate of approximately 2 drops per second. The extract was filtered through 5 spatulas of anhydrous sodium sulfate in a sulfur tube into a Kuderna-Danish (KD) evaporator flask. The sodium sulfate and the round flasks were rinsed with 10 ml $MeCl_2$ each. The extracts were evaporated in the KD to approximately 5 ml and then transferred into graduated concentrator tubes. Further concentration was done by gently blowing purified nitrogen over the extract. The final 500 µl-extract was spiked with d_{10}-anthracene solution, transfered to a 2 ml vial, and stored under refrigeration until analysis.

Acids/Phenols (A/P) -- After extraction of the B/N fraction the pH was lowered to 2 by adding 6N hydrochloric acid. The pH was checked with pHydron 1-2.5 paper. 4-Bromophenol was added as a surrogate standard. Another round flask containing 325 ml $MeCl_2$ and boiling chips was mounted and $MeCl_2$ recirculation resumed. After 24 hours, the extract was dried and concentrated as described for the B/N fraction. To the 200 µl-concentrate, 1 ml of a 50/50 (v/v) methanol/ether solution and an appropriate amount of d_{10}-anthracene was added as an internal standard. The extract was stored at 4°C until methylation.

Methylation of A/Ps -- Methylation was executed a few days prior to GC/MS analysis. Four ml or an excess of ethereal diazomethane solution was added to the extract. After mixing, the sample was allowed to sit in the hood overnight. The next day, the solution was concentrated with nitrogen to approximately 1 ml and transferred to a 2 ml vial. Concentration to the final volume of 200 µl was done in the vial with a nitrogen stream. The extracts were stored at 4°C until GC/MS analysis.

GC/MS - Analysis -- Identification and quantification for B/Ns and A/Ps was performed on a Finnigan GC/MS system model 4000, controlled by an INCOS data system (Finnigan, Sunnyvale, CA 94086). The gas chromatograph was equipped with a Grob injector (E.M. Becker Co., Bala Cynwyd, PA 19004). A 50-m fused silica column coated with SE-52 (J & W Scientific, Rancho Cordova, CA 95670) was mounted in the GC with the outlet connected directly to the MS. Helium was used as the carrier gas. The pressure was adjusted to 0.5 bar. The GC conditions were as follows: injector temperature 250°C, temperature program 50°C for 1 min then 3°C/min increase to 300°C; the interface oven and the transfer line were set to the maximum temperature of 300°C. 1.5 µl of the extract was injected using the hot-needle technique with a splitless time of 0.6 min (11). The MS aquisition parameters were as follows: electron energy 70 eV, electron current 0.5 mA, ionizer temperature 220°C. The data system aquisition parameters were: MID mode, 2 secs per scan, mass range (in AMUs) 35-235 in 0.666 secs, 236-420 in 1.226 secs, threshold 1. The quantitation procedure developed to quantify B/Ns and A/Ps was composed of subroutines (indicated in capital letters) provided for by the data system. It featured a search for the internal standard using the SEAR routine, identification of the compounds with MAP, quantification of the peaks indentified in MAP with CHRO using a characteristic ion and calculation of the concentration with QUAN. To facilitate review of the data, multiple mass chromatograms were plotted routinely, including characteristic ions. Since many compounds were not identified unambiguously, spectra were checked with LIBR or manually.

Organic Priority Pollutants Measured -- Of the 114 organic priority pollutants (9), the analytical procedures used were capable of detecting 100 of them. The other fourteen were not measureable by the techniques used; these include bromo-, chloro-, dichlorodifluoro- and trichlorofluoromethane, chloroethane, vinyl chloride, acrolein, acrylonitrile, benzene, 3,3-dichlorobenzidine, benzidine, N-nitrosodimethylamine, endosulfan sulfate, and endrin aldehyde. Of the 100 detected, 81 could be analyzed quantitatively, but 19 involved analytical problems such as volatility, instability in water, or detector interference, making quantification questionable; included here are chloroethers, indeno (1,2,3-c,d) pyrene, benzo (g,h,i) perylene, dibenzo (a,h) anthracene, 1,2-diphenylhydrazine, fluorene, dinitrotoluenes, chorophenol, phenol, DDT, lindane, chlorobenzene, 1,2-dichloroethane, t-dichloroethylene, dichloropropene, and phthalates. Of the latter, lindane, DDT, chlorobenzene and phthalates were the only compounds in sufficient concentration for quantification, but because of the analytical problems, the data must be suspect. Analytical problems were especially severe because concentrations were in almost all cases well below the 10 µg/l suggested as a reasonable detection limit for analysis in polluted waters (9). Even so, most of the compounds for which the techniques were suitable could be analyzed with detection limits generally of 0.01 to 0.05 µg/l.

Quality Assurance, Quality Control -- The measures to control and assure the quality of analytical data included quantification based on surrogate standards, analysis of duplicate samples, periodic recalibration of analytical equipment and procedures, checking solvent and Milli-Q-water blanks. Since surrogate standards were added to all samples, this helped insure that hourly and daily variations in analytical sensitivity would not affect the quantification for individual constituents. A comparison between recovery efficiencies for the surrogate standards and compounds of interest from the concentration step of each analysis is provided in Appendix G. Some of the more ubiquitous compounds analyzed such as the phthalates were present in Milli-Q-water, however, and background levels were difficult to control. Other problems encountered with quality control and quality assurance are discussed in Section 7.

ANALYTICAL ERRORS

The acuracy and precision of analyses for inorganic constituents including heavy metals, and collective and surrogate parameters are outlined in Standard Methods (7). Analytical detection limits and precision for organic analyses as determined from collection, shipment, and analysis of duplicate samples for trace organic constituents are summarized in Table 4. The numbers of duplicates used to estimate the coefficient of variation for the various compounds are also listed. These duplicates were collected periodically over the course of the study so that the variations noted represent that for the entire period of study. The analytical detection limits were estimated from differences between duplicate concentrations for constituents that were near the detection limit in given samples. The detection limits listed represent conservative estimates of the ability to detect peaks that were significatnly greater than the instrument noise level. In general, the detection limits represent peak areas that are two to four times that provided by instrument noise. The precision, expressed as coefficient of variation, was generally in the range of 50 percent except for VOA analysis, for which it was about 15 percent.

TABLE 4. DETECTION LIMITS AND COEFFICIENT OF VARIATION OF ANALYTICAL AND SAMPLING ERRORS FOR TRACE ORGANIC ANALYSES

Analytical Test	Detection Limit µg/l	No. Duplicate Samples Analyzed	Coefficient of Variation %
VOA		138	
General Values	0.05		15
Exceptions:			
Dibromochloromethane	0.1		15
Bromoform	0.2		15
CLSA		25	
Chlorinated Benzenes	0.01		25
Aromatic Hydrocarbons	0.01		90
SEA		17	
Pesticides			
General Values	0.05		25
Exceptions:			
DDT	0.1		50
PCB	0.1		50
Toxaphene	0.1		50
Phthalates*			
General Values	0.3		60
Exceptions:			
Diethylhexylphthalate	4.0		60
Other Compounds	0.3		50
B/N		6	
General Values	0.02		50
Phthalates	0.1		50
A/P		5	
General Values	0.05		50

*Data not used in main body of report because of high detection limit.

SECTION 6

DATA ANALYSIS

SELECTION OF DISTRIBUTION MODEL

The characteristics of the influent and effluent waters, and the performance of WF21, vary from day to day. In order to interpret the data obtained from monitoring, a model that adequately describes the probability distribution of each organic and inorganic contaminant at each location is needed. In the previous report on WF21 performance (2) several probability models were considered, parameters for each were evaluated using various sets of organic and inorganic data, and the results of model predictions were compared to determine which model most consistently provided good statistical correlation with the data. Models for normal and lognormal probability distributions received most consideration since they gave reasonable fits to much of the data and also readily lend themselves to statistical interpretation. From this analysis it was found that the lognormal distribution provided the most adequate description of the probability distribution for organic and inorganic materials at WF21. The lognormal distribution was thus used in this current study for analyzing the WF21 data.

CHARACTERISTICS OF THE LOGNORMAL DISTRIBUTION

In order to characterize the frequency distribution of a set of data for a given constituent at a given sampling point, it is first necessary to verify that no marked changes in the concentration took place over the period as a result of non-random events such as a change in plant operation. Then logs of each datum were taken and the average and standard deviation was calculated by common statistical procedures for a normal probability distribution. The antilog of the mean so obtained represents the geometric mean, M, and the antilog of the standard deviation gives the spread factor, S. For a lognormal distribution 68.3 percent of the data will lie between concentrations represented by M/S and MS, and 95.5 percent of the data will lie between M/S^2 and MS^2.

A significant problem arises when all of the data in a set do not lie above the analytical detection limit. For such a case, a procedure was devised that allowed these data to be analyzed by lognormal statistics. Lognormal graph paper is available that allows one to plot such data in a descending order from highest to lowest values as a function of the percentage of values that are less than any given plotted value. If the data follows a lognormal distribution, then a straight line should pass through all the data (12). The concentration represented by the 50 percent less than value represents the geometric mean, and the slope of the line represents the spread factor.

While the graphical approach is suitable for analyzing data for which some is below the detection limit, this would be a tedious and time-consuming procedure if it were to be used to analyze all the data generated from this project. Therefore, a computerized procedure was used for arranging the data, calculating distributions, and creating a least-squares fit line through the data to allow determination of the geometric mean and spread factor.

The first step in this analysis was to arrange the data in descending rank order, and the probability distribution F* for each measured concentration was determined from (11):

$$F^*(X^{(i)}) = \frac{i - 3/8}{N + 1/4} \qquad (6\text{-}1)$$

where $X^{(i)}$ is the i^{th}-largest observed value in the random sample of size N. Equation 6-1 rather than $F^*(X^{(i)}) = i/N$ was used in order to avoid endpoint problems.

Normally distributed data will plot as a straight line on probability paper if the ordinate scale is arithmetic, while lognormally distributed data will plot as a straight line if the ordinate scale is logarithmetic. For the latter distribution, the logs of the ordered data is then taken.

In order to plot the data, the abscissa probability function needs to be linearized. Ryan et al. (11) have provided an approximate formula for doing this:

$$P(i) = 4.91 \quad (F(X^{(i)})^{0.14} - (1 - F(X^{(i)})^{0.14}) \qquad (6\text{-}2)$$

This generates values of zero at the 50 percent probability level, and +1 and -1 at the 84.2 and 15.8 percent probability levels (representing one standard deviation above and below the mean, respectively). The value would be +2 and -2 for probabilities two standard deviations above and below the mean, respectively, etc. A least squares fitting between the $F(X^{(i)})$ and P(i) values results in a line that has as the zero intercept, the log of M, and a slope representing log S. From the antilogs, the values of M and S were determined. The procedure was computerized for ease in data handling.

In order to give a better indication of the uncertainty in calculated M values, the 95-percent confidence interval (CI) was determined by

$$95\%\ CI = MS^{\pm (t \sqrt{N_u})} \qquad (6\text{-}3)$$

where t is the value from a t-distribution table for a two-tailed 0.95 point with N_u - 1 degrees of freedom. Nu represents the number of data points above the analytical detection limit.

At times it was desirable to determine the efficiency of a given process or of a combination of processes. This was generally computed as follows:

% Removal Efficiency = 100 (Mi-Me)/Mi (6-4) where Mi and Me are the geometric mean influent and effluent concentrations, respectively, for the process or combination of processes. The 95% confidence interval for the average removal efficiency was determined from:

$$95\%\ \mathrm{CI} = 100\ [\ 1 - \frac{Me}{Mi}\ (10^{\pm t s_r})\ ] \qquad (6\text{-}5)$$

in which,

$$s_r = [\ (\log S_i)^2/Nu_i + (\log S_e)^2/Nu_e\ ]^{1/2} \qquad (6\text{-}6)$$

and t is based upon a two-tailed 0.05 level of significance with $Nu_i + Nu_e - 1$ degrees of freedom. The confidence interval for percent removal provides a measure of the adequacy of the data for drawing firm conclusions about removal efficiency.

In summary, the lognormal distribution was used for analysis of data obtained from WF21. A summary of the data for a given compound or parameter at a given sampling location over a given interval is represented by the geometric mean (M), the spread factor (S), 95-percent confidence interval of the mean (95% CI), the total number of data points (N), the number of data points above the analytical detection limit (Nu), and the range of data (R), which includes the lowest and highest measured values among the N data. This statistical analysis can provide the information needed to make decisions concerning the reliability of WF21 to meet given standards, and allowed an evaluation of the overall performance of the treatment system.

SECTION 7

PLANT OPERATION AND PERFORMANCE

INTRODUCTION

This report covers the three-year period of plant operation from March 1, 1978 to April 1, 1981, during which the plant received unchlorinated secondary effluent from the CSDOC activated sludge plant. Monitoring for a range of inorganic, organic, and biological constituents was conducted during the entire period, but a more intense monitoring for trace inorganic elements and nearly the entire range of priority pollutants was begun in January 1980. Summaries of analytical data both for the entire three-year period of this study, and also for the last 15-month period of more intensive study are contained in Appendices C and D. Data summarized in this section represents that for the entire period unless otherwise noted.

PROCESS LOADINGS

The flow rate to the various processes varied during this study. Figure 4 illustrates the flowrate which entered the plant (Q1), that which received GAC treatment only (Q9), and that which also received RO treatment (Q22B). The nominal plant capacity of 0.66 m^3/s corresponds to 57,000 m^3/day and that for the RO facility of 0.22 m^3/s to 19,000 m^3/day. The RO facilities were operated near full capacity essentially for the entire period reported, but the Q9 stream varied considerably due to changing needs for reclaimed water and changing operating philosophies. During this time the number of GAC columns operated was varied so that the flow rate per column remained relatively constant. Portions of the plant were shut down for maintenance at various times and this is indicated by significant drops in Q1 and Q9 flows. The computer graphics used to produce the curves such as in Figure 4 contained a smoothing routine for better visual evaluation, but this resulted in some distortion of sudden events such as a plant shut-down. The fans associated with the stripping towers were not operated after April 23, 1978 or almost for the entire period of this study in order to save energy costs.

A major reason for reducing the Q9 flow after January 1980 was stoppage of nitrification of wastewater delivered to WF21, which resulted in an increase in ammonia concentration (Figure 5) and a decrease in nitrate concentration (Figure 6) in the influent. While some reduction of ammonia was achieved at Q9 by chlorine oxidation (Figure 5), costs of further reduction to meet the required 4 mg/l level by additional chlorination or operation of the stripping fans was considered excessive, particularly since increased groundwater levels had decreased injection water requirements. This made possible the operation of the barriers at reduced flow levels. Since RO treatment and

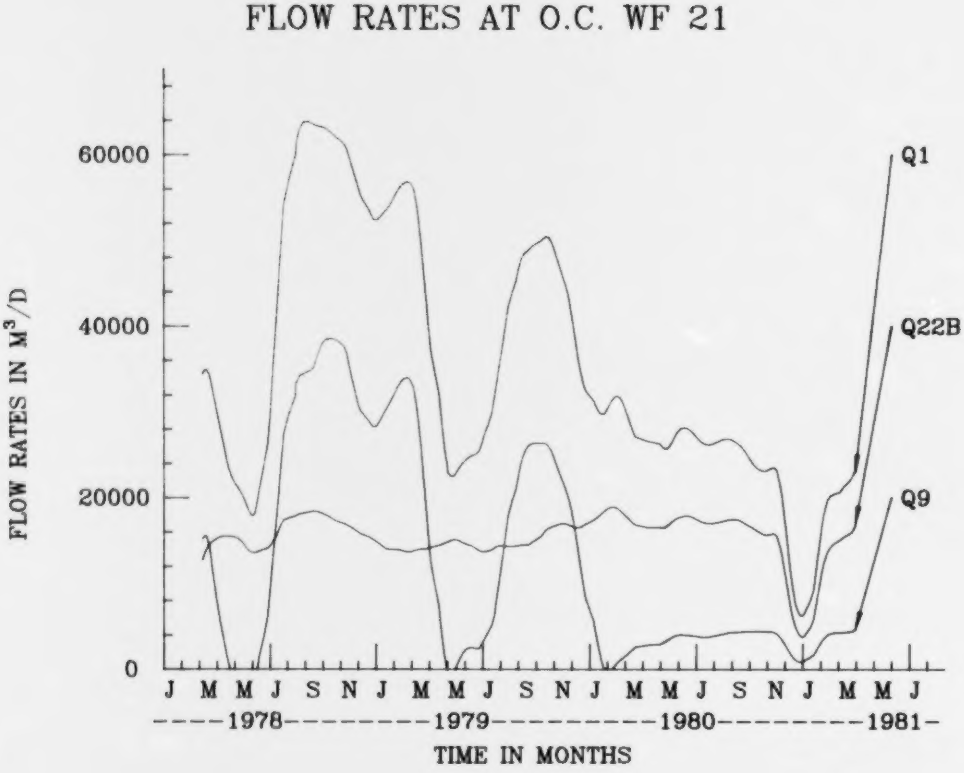


Figure 4. Flow rates at WF21 for the influent (Q1), the chlorinated effluent (Q9) and the RO effluent (Q22B).

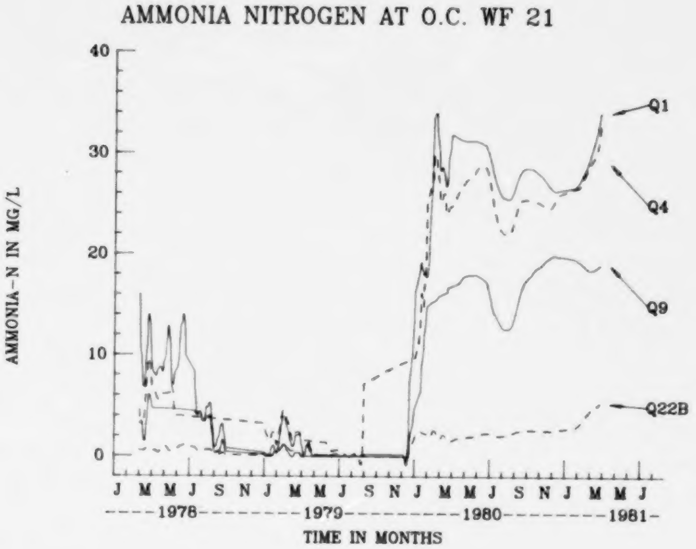


Figure 5. Ammonia-nitrogen concentrations at various sampling locations with time.

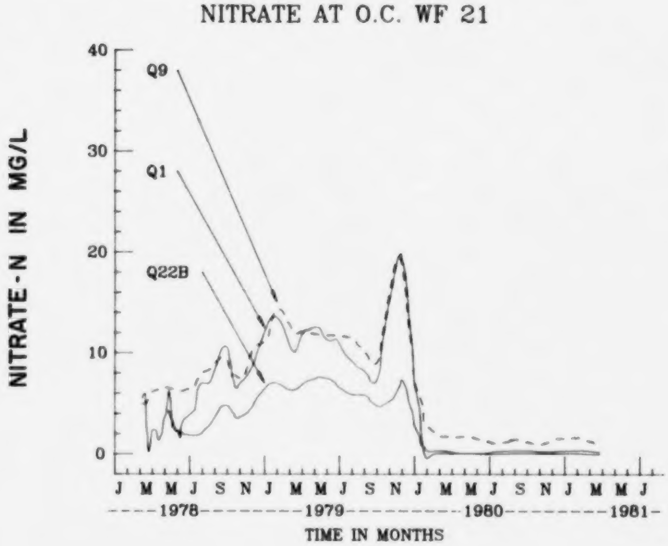


Figure 6. Nitrate-nitrogen concentrations at various sampling locations with time.

blending with deep well water generally resulted in more than adequate ammonia reduction to meet requirements for the blended injection water, it was decided to operate the plant at reduced capacity.

A detailed weekly summary of flow rates and other operational characteristics is given in Appendix E. Table 5 contains a summary of the plant flow through various processes during different periods of this study. The periods represent times over which the flow rates to all processes remained relatively constant and operation was planned to meet specific objectives or was changed in response to a given need. Average values for the entire period are given at the bottom. These values exclude the major shutdown periods.

At periods when the plant flow was below the design flow, all units associated with a given process were not necessarily operated. The number of units operated and the percentage of design flow the operating units received during the different periods within this study are listed in Table 6. The average values listed at the bottom of the table indicate that the processes on the average operated between 65 and 80 percent of design flow. Exceptions are values of 23 percent for the final chlorination basin and 100 percent for the RO system.

During certain periods listed in Tables 5 and 6, the entire plant or portions of the plant were shutdown for emergency or other repairs. The length of time and reasons for such shutdowns are described in Section 11.

GENERAL PLANT PERFORMANCE

General characteristics of the influent and treated wastewater are summarized in Table 7 together with the number of samples on which the geometric mean concentrations are based. Analyses for certain constituents such as chloride, fluoride, and sulfate were not conducted for sampling locations Q2 and Q6 prior to 1980. Thus, direct comparisons between average concentrations at these locations and those at Q1 and Q9 are not necessarily valid. For example, this difference in sampling times is the reason for the higher average chloride concentration at Q2 than at Q1. Other concentration changes, however, show the effects of treatment. High-lime treatment resulted in reduction of magnesium concentration, and chlorination at Q4 and Q8 resulted in increased chloride concentration, but the largest change resulted with RO treatment yielding a 90 percent reduction in overall inorganic constituents and a significant reduction in COD as well.

Concentration changes with time of general organic materials as represented by the collective parameters of COD and TOC are shown in Figures 7 and 9, respectively. The generally lower TOC concentration in RO effluent after May 1979 is largely the result of switching TOC analyses to an automated instrument designed specifically for low concentration measurements. The data for low concentration values prior to that time are of lesser accuracy.

Removals of the organics collectively occurred primarily through lime treatment (Q2), GAC treatment (Q8), and RO treatment (Q22B). Percentage removals of COD and TOC as illustrated in Figures 8 and 10 indicate the consistent efficiency of removal obtained.

TABLE 5. FLOWRATES FOR INDIVIDUAL PROCESSES FOR VARIOUS PERIODS THROUGHOUT THE STUDY PERIOD

Period		Flow Rates m^3/s ± Standard Deviation				
Dates	Days	Influ through Filtration Q1-Q6	GAC Q6-Q8	AWT Eff Q8-Q9	RO Inf Q22A	RO Eff Q22B
3/6/78-4/2/78	28	0.42 ± 0.03	0.39 ± 0.03	0.19 ± 0.02	0.21 ± 0.02	0.18 ± 0.02
4/3/78-6/18/78	77	0.24 ± 0.03	0.20 ± 0.03	0.00	0.20 ± 0.03	0.17 ± 0.04
6/26/78-7/9/78	14			SHUT-DOWN FOR MAINTENANCE		
7/10/78-4/1/79	266	0.64 ± 0.10	0.58 ± 0.09	0.37 ± 0.08	0.22 ± 0.03	0.18 ± 0.02
4/2/79-7/22/79	112	0.30 ± 0.02	0.22 ± 0.02	0.02 ± 0.02	0.20 ± 0.02	0.17 ± 0.01
7/23/79-12/23/79	154	0.52 ± 0.09	0.46 ± 0.09	0.25 ± 0.08	0.21 ± 0.02	0.18 ± 0.02
12/24/79-4/27/80	125	0.35 ± 0.05	0.27 ± 0.05	0.01 ± 0.3	0.24 ± 0.05	0.20 ± 0.05
4/28/80-5/11/80	14			SHUT-DOWN FOR MAINTENANCE		
5/12/80-12/14/80	217	0.29 ± 0.04	0.29 ± 0.02	0.05 ± 0.01	0.23 ± 0.02	0.19 ± 0.02
12/15/80-1/18/81	35			SHUT-DOWN FOR MAINTENANCE		
1/19/81-3/31/81	72	0.23 ± 0.04	0.27 ± 0.04	0.06 ± 0.02	0.20 ± 0.03	0.16 ± 0.02
Avg. for Total Period*		0.42 ± 0.17	0.38 ± 0.16	0.16 ± 0.15	0.21 ± 0.03	0.18 ± 0.03

*Excludes shut-down periods

TABLE 6. FLOWRATES AS PERCENTAGE OF DESIGN FLOWRATES FOR UNIT PROCESSES

		Lime Treat		Stripping Towers		Recarb		Filtration		GAC		RO	Final Chlor
Period	Days	Avg. No. Basins#	% Design Flow	Avg. No. Towers#	% Design Flow	Avg. No. Basins#	% Design Flow	Avg. No. Filters#	% Design Flow	Avg. No. Col#	% Design Flow	% Design Flow	% Design Flow
3/6/78–4/2/78	28	2	64	1	128	1	127	4	64	13.0	69	94	28
4/3/78–6/25/78	84	2	36	1.5	50	1.6	45	3.1	47	6.5	71	92	0
6/26/78–7/9/78	14			SHUTDOWN FOR MAINTENANCE									
7/10/78–4/1/79	266	1.9	102	2	96	1.9	102	4	97	14.3	92	100	56
4/2/79–7/22/79	112	1.9	48	1.5	60	1.6	57	3.5	52	10.4	48	90	4
7/23/79–12/23/79	154	2	79	2	79	2	79	4	79	12.9	81	98	37
12/24/79–4/27/80	125	1.5	71	2	55	1.9	56	4	53	9.9	65	110	6
4/28/80–5/11/80	14			SHUTDOWN FOR MAINTENANCE									
5/12/80–12/14/80	217	1	88	1	88	1	88	4	44	10.9	61	106	7
12/15/80–1/18/81	35			SHUTDOWN FOR MAINTENANCE									
1/19/81–3/21/81	72	1	70	1	69	1	70	4	35	8.8	68	90	9
Avg. for Total Period*			78		79		80		65		72	100	23

*Excludes shutdown periods

#Fractional numbers indicate that the number of units operated over the period varied.

TABLE 7. WF21 AVERAGE GENERAL WATER CHARACTERISTICS AT DIFFERENT SAMPLING LOCATIONS DURING STUDY PERIOD*

Characteristics	Inf Q1	Chem Eff Q2	Filt Eff Q6	Chlor Eff Q9	RO Eff Q22B
TDS, mg/l	940	1010	997	921	90
	(154)	(56)	(26)	(103)	(146)
Ca, mg/l	86	90	85	85	1.3
	(400)	(362)	(340)	(230)	(183)
Mg, mg/l	23	2	2	4	0.0
	(156)	(58)	(26)	(108)	(49)
Na, mg/l	178	231	225	194	22
	(123)	(25)	(26)	(104)	(619)
K, mg/l	14	14	14	14	1.1
	(26)	(25)	(26)	(48)	(53)
B, mg/l	0.79	0.63	0.63	0.59	0.52
	(156)	(58)	(26)	(104)	(52)
F, mg/l	1.3	0.9	0.9	0.74	0.16
	(121)	(26)	(25)	(107)	(54)
Cl, mg/l	236	263	279	299	28
	(263)	(185)	(181)	(185)	(510)
Alkalinity (mg/l as CaCO$_3$)	204	253	154	50	17
	(358)	(361)	(343)	(197)	(168)
SO$_4$, mg/l	269	261	285	258	3
	(258)	(178)	(175)	(182)	(496)
Total Coliform/ 100 ml	4.2×10^5	0.3	<0.3	<0.3	1.4
	(127)	(120)	(505)	(509)	(345)
Fecal Coliform/ 100 ml	4.3×10^4	0.03	<0.3	<0.3	<0.3
	(127)	(120)	(519)	(510)	(346)
COD, mg/l	47	27	25	8.4	0.9
	(667)	(667)	(666)	(182)	(632)
TOC, mg/l	14	11	11	6	1.0
	(254)	(257)	(254)	(118)	(214)
Gross Alpha, pCi/l	1	0.8	0.8	0.6	0.8
	(25)	(14)	(12)	(25)	(26)
Gross Beta, pCi/l	21	16	13	14	4
	(25)	(14)	(12)	(25)	(26)

* Values given are geometric means, values in parentheses represent number of samples analyzed.

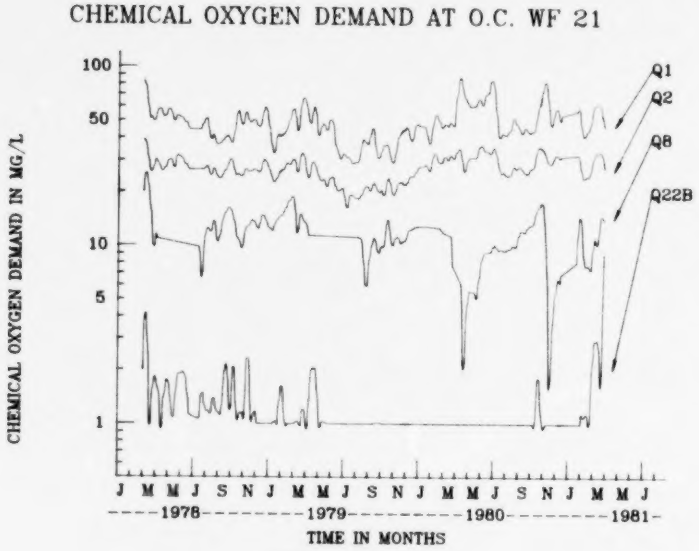


Figure 7. Variation in COD with time at various sampling locations. Detection limit was 1 mg/l, values measured to be less than this are indicated as 1 mg/l.

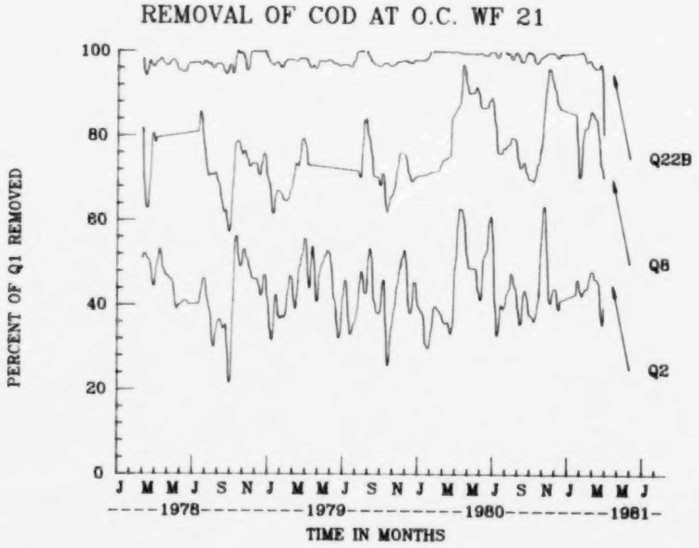


Figure 8. Percentage removal of COD with time after various stages of treatment.

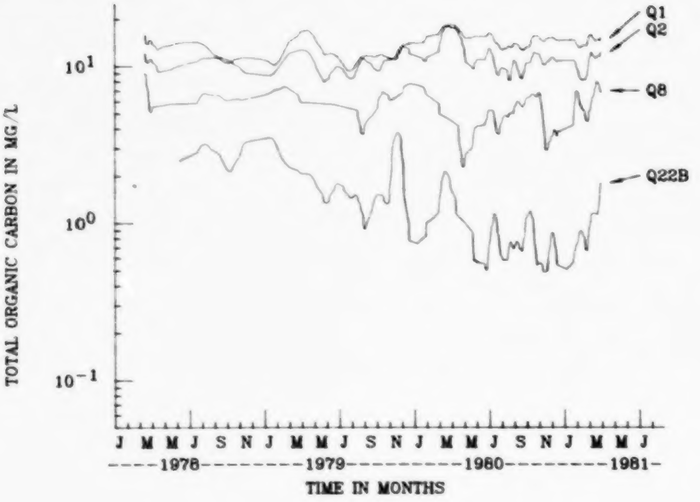


Figure 9. Variation in TOC with time at various sampling locations.

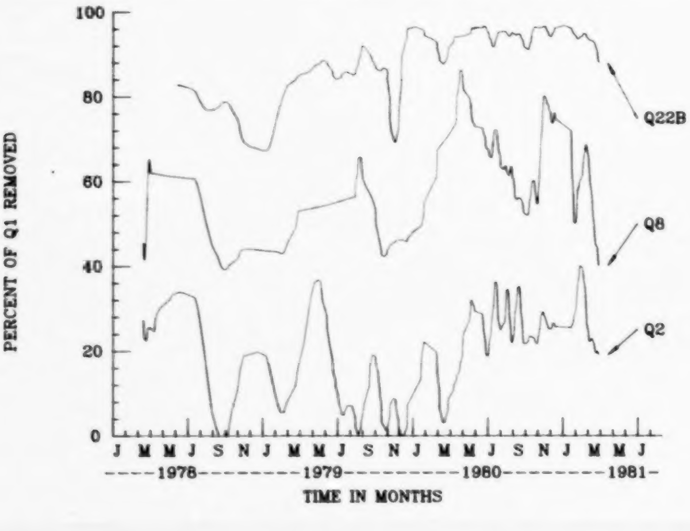


Figure 10. Percentage removal of TOC with time after various stages of treatment.

In Figures 7 through 10 the AWT effluent at Q8 is shown. State requirements for COD were specified for Q8 and so no measurements were made of the chlorinated effluent at Q9. However, beginning with the intensive analytical program in January 1980, analyses were conducted at Q9 as well.

The COD and TOC data can be represented perhaps better with frequency distributions as illustrated in Figures 11 and 12.

Data are shown here for the period beginning in 1980 when TOC measurements were available for the chlorinated effluent. Chlorination had no effect on COD concentration, but did increase the TOC measured values by 1.1 mg/l (see Appendix D). An intensive study of the TOC analytical method demonstrated that high combined-chlorine residuals caused a positive interference in the measurement. Thus, the higher measured values at Q9 compared with Q8 are the result of instrumental error. The variability of the measured parameter is reflected in the slope of the lines, and a comparison indicates TOC varied less in the GAC and RO effluents than COD. The COD variability is largely a result of lack of precision at low concentrations. As indicated in Standard Methods (7), the COD test can only be used to give order of magnitude values at concentrations less than 10 mg/l.

PRIORITY POLLUTANT REMOVAL

Inorganic Priority Pollutants

Table 8 summarizes the average concentrations of inorganic priority pollutants after various stages of treatment, and Table 9 indicates the cumulative percentage removals after various stages of treatment for selected elements for which concentrations were sufficiently above the detection limit for quantification. The data are for the period after January 1980 when intensive study for these elements was begun. Shown in these tables are 95 percent CI values which give a measure of the confidence which can be placed in the summary values reported. Confidence intervals tend to be large for constituents for which the variability was great, concentrations were near the detection limit, or sample numbers were small. The differences between Q8 and Q22A removals (Table 6) represent differences in treatment by different sets of GAC columns as discussed in Section 4.

The treatment processes most effective in removal of priority inorganic materials are lime and RO treatment. Percentage removals by these two processes by themselves are summarized in Table 10. Results for lime treatment are further illustrated in Figure 13 which shows the frequency distributions in the lime treatment influent and effluent.

The concentrations of copper and lead increased significantly during final chlorination (Q9). The cause has not been evaluated as the higher concentrations remained within acceptable levels, but the likely cause is corrosion of the copper chlorine feed lines. Iron increased in concentration between Q2 and Q6 due to corrosion in the stripping towers.

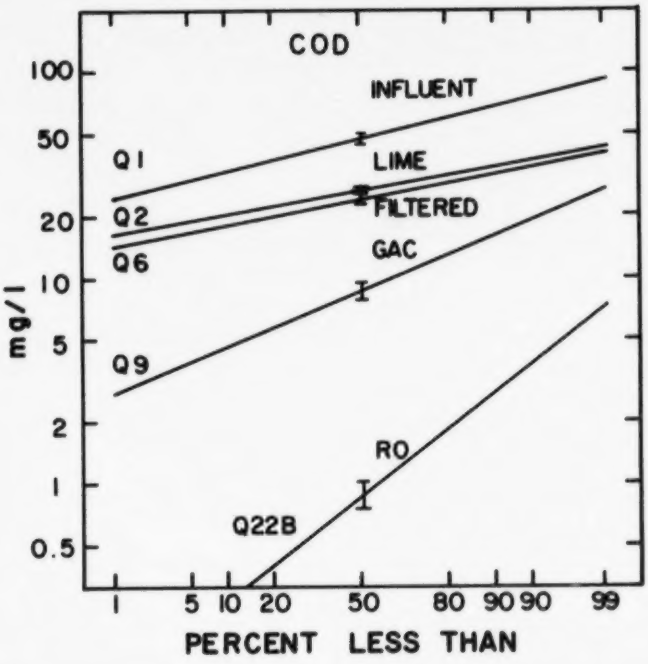


Figure 11. COD frequency distribution after various stages of treatment for period March 1980 through March 1981.

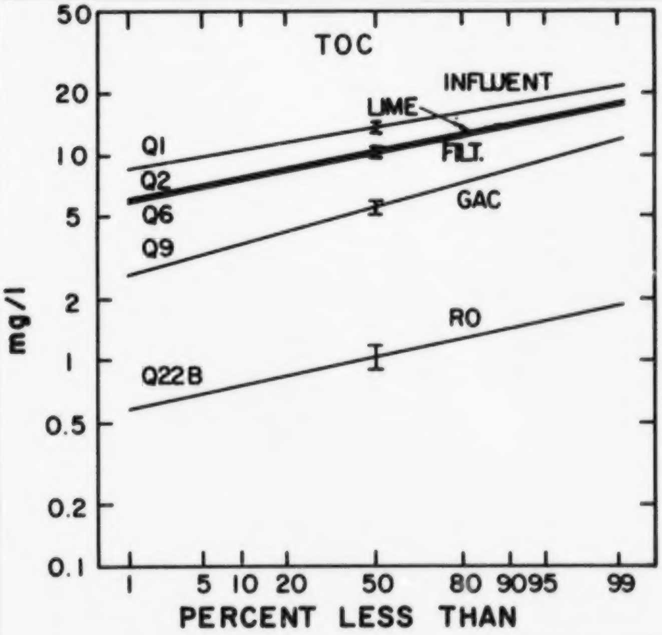


Figure 12. TOC frequency distribution after various stages of treatment for period March 1980 through March 1981.

TABLE 8. TRACE INORGANIC ELEMENT CONCENTRATIONS AT VARIOUS SAMPLING LOCATIONS FOR THE PERIOD JANUARY 1980 THROUGH MARCH 1981, μg/1*

Element	Inf Q1 (n=56)	Chem Eff Q2 (n=27)	Filt Eff Q6 (n=27)	Chlor Eff Q9 (n=46)	RO Eff Q22B (n=51)
Arsenic	<5	<5	<5	<5	<5
Barium	94 (81-107)	35 (28-45)	33 (26-42)	43 (37-49)	1.1 (0.8-1.7)
Beryllium	0.3 (0.1-0.8)	0.4 (0.1-1.3)	0.2 (0.01-5)	0.4 (0.1-2)	<1
Cadmium	9 (7-12)	1.9 (1.2-2.9)	1.7 (1.1-2.6)	1.2 (1-1.6)	0.1 (0.04-0.12)
Cobalt	2.2 (1.5-3.3)	1.2 (0.4-3.4)	1.2 (0.5-3.3)	0.7 (0.2-1.8)	<1
Chromium	33 (29-38)	8 (6-11)	7 (5-9)	7 (5-9)	0.8 (0.44-1.5)
Copper	49 (43-56)	9 (7-13)	18 (16-22)	154 (113-209)	4 (3-5)
Iron	114 (100-130)	19 (14-26)	103 (75-142)	51 (42-63)	3 (2-5)
Lead	5 (4-6)	0.5 (0.1-2)	0.6 (0.1-2.5)	4.5 (3-7)	0.6 (0.4-1.1)
Manganese	56 (51-62)	1.3 (0.7-2.4)	6 (4-8)	5 (4-6)	0.1 (0.05-0.4)
Mercury	0.3 (0.2-0.5)	0.1 (0.02-0.8)	0.4 (0.2-0.7)	0.6 (0.4-0.8)	0.3 (0.16-0.5)
Nickel	77 (67-88)	27 (23-32)	25 (20-30)	19 (17-22)	1.5 (0.9-2.4)
Selenium	<5	<5	<5	<5	<5
Silver	1.6 (1.3-1.9)	0.4 (0.2-0.6)	0.5 (0.3-0.8)	0.5 (0.3-0.7)	0.15 (0.09-0.23)

* Values in parenthesis represent 95% confidence interval for geometric mean.

TABLE 9. CUMULATIVE PERCENTAGE REMOVAL OF TRACE INORGANIC CONTAMINANTS AFTER VARIOUS STAGES OF TREATMENT FOR THE PERIOD JANUARY 1980 THROUGH MARCH 1981

	Lime Q2	Filt. Q6	GAC Q8	Chlor. Q9	RO Inf. Q22A	RO Eff Q22B
Aluminum	70 (39-85)	64 (36-80)	42 (0-66)	60 (35-75)	55 (2-79)	92 (87-95)
Barium	68 (56-76)	68 (56-76)	59 (42-71)	48 (35-58)	56 (35-71)	98.6 (97.8-99.1)
Beryllium	-23 (-333-65)	20 (-390-87)		-37 (-470-67)	77 (-530-99)	
Cadmium	80 (68-87)	82 (71-88)	85 (77-91)	87 (82-90)	83 (68-91)	99.2 (98.7-99.6)
Chromium	76 (67-83)	80 (73-85)	88 (82-92)	92 (85-95)	93 (89-96)	98 (95-99)
Cobalt	47 (-56-82)	43 (-55-79)	74 (-18-94)	70 (14-89)	53 (-128-91)	99.8 (93-100)
Copper	81 (74-86)	62 (54-69)	89 (84-92)	-212 (-336-123)	82 (77-86)	92 (90-94)
Iron	84 (77-88)	10 (-27-35)	76 (69-81)	55 (43-65)	66 (48-78)	98 (96-99)
Lead	89 (63-97)	88 (56-97)	89 (60-97)	5 (-53-41)	14 (-45-49)	86 (78-91)
Manganese	98 (96-99)	90 (86-93)	94 (90-96)	92 (90-94)	97 (96-98)	99.8 (99.4-99.9)
Mercury	61 (-88-92)	-24 (-142-36)	-18 (-150-44)	-73 (-207-3)	-107 (-297-(-7))	15 (-71-58)
Nickel	65 (56-71)	68 (59-74)	79 (74-83)	75 (69-79)	69 (56-78)	98 (97-99)
Silver	76 (62-85)	70 (51-81)	78 (63-87)	70 (53-80)	74 (46-88)	91 (85-94)

Values represent geometric mean percentage removal and 95 percent CI for the mean (brackets).

TABLE 10. PERCENTAGE REMOVALS OF TRACE INORGANIC ELEMENTS BY LIME TREATMENT AND REVERSE OSMOSIS (JANUARY 1980 THROUGH MARCH 1981)

	Percentage Removals		
Element	Lime Treatment (Q1 to Q2)	Reverse Osmosis (Q22A to Q22B)	Overall (Q1 to Q22B)
Barium	68 (56-76)	97 (95-98)	98.6 (97.8-99.1)
Cadmium	80 (68-87)	96 (91-98)	99.2 (98.7-99.6)
Chromium	76 (67-83)	65 (25-84)	98 (95-99)
Cobalt	NS	>99	99.8 (93-100)
Copper	81 (74-86)	56 (39-68)	92 (90-94)
Iron	84 (77-88)	93 (86-96)	98 (96-99)
Lead	89 (63-97)	84 (67-92)	86 (78-91)
Manganese	98 (96-99)	NS	99.8 (99.4-99.9)
Mercury	NS	59 (18-79)	NS
Nickel	65 (56-71)	94 (89-97)	98 (97-99)
Silver	76 (62-85)	63 (15-84)	91 (85-94)

NS — Removals not statistically significant
Values represent geometric mean percentage removal and 95 percent CI for the mean (brackets).

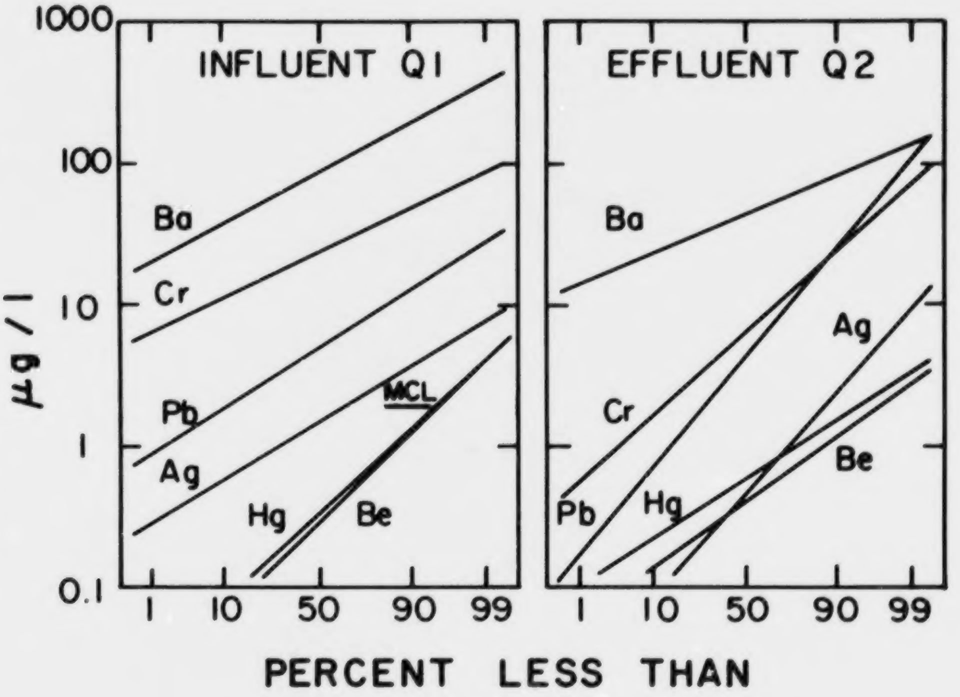


Figure 13. Frequency distribution for priority inorganic elements in lime treatment influent and effluent.

Maximum contaminant levels (MCL) are contained in the EPA interim primary drinking water regulations for several of the inorganic priority pollutants. Generally, the inorganic contaminants were less than the MCL values in influent waters to WF21. However, the average concentration for cadmium exceeded the MCL value in the WF21 influent. The MCL value for cadmium is 10 μg/l, and as illustrated by the frequency distribution in Figure 14, this value was exceeded after lime treatment less than 20 percent of the time and after GAC treatment less than 1 percent of the time. The concentration of mercury in WF21 influent exceeded the MCL of 2 μg/l somewhat less than 10 percent of the time, but only exceeded it once (3.6 μg/l) in 49 samples of chlorinated (Q9) effluent and twice (2.2 μg/l maximum) in 50 samples of RO (Q22B) effluent. There is some question about the significance of these higher values since the MCL for mercury is so close to the analytical detection limit of the procedures used. In general it appears that at WF21, concentrations of inorganic priority pollutants in the GAC and RO effluents do not pose a significant health risk.

Organic Priority Pollutants

Of the 100 organic priority pollutants sought by the analyses used, only 25 were found routinely in the influent to WF21 in sufficient concentrations to be reasonably quantifiable. These together with their influent geometric means, number of samples analyzed, and other statistical information are listed in Table 11. Other compounds were detected on occasion, but the data were not sufficient to allow quantification. These compounds are listed in Table 12 along with frequency of detection and maximum concentrations found. For compounds which were in sufficient concentration for quantification after filtration (Q6), GAC treatment and chlorination (Q9), and RO treatment (Q22B), appropriate statistical information is given in Tables 13, 14, and 15.

The influent concentrations of some organic compounds were very low, making it difficult to quantify the role of each process in further removals obtained. However, for a few compounds with higher influent concentrations, this was possible. Cumulative average percentage removals through the treatment plant and 95 percent CI for these averages after various stages of treatment are summarized in Table 16. Most of the compounds represented are volatile and so were quite efficiently removed by the stripping towers. These compounds also tended to be removed well by the decarbonators following RO treatment as indicated by the increase in percentage removal between Q9 and Q22B. The fact that decarbonation rather than RO treatment was responsible for this removal was demonstrated previously(2). GAC was no doubt also effective in achieving some removal of these materials, but this removal was difficult to quantify. Even with Q9 data, however, difficulty in evaluation was experienced. This is indicated by the overlap in the 95 percent CI values for percentage removals between Q6 and the chlorinated effluent after GAC treatment Q9 (Table 16).

Distributions of concentrations at various sampling locations are shown in Figures 15 and 16 for 1,4-dichlorobenzene and 1,2,4-trichlorobenzene, respectively. The major removal process for 1,2,4-trichlorobenzene was GAC, while for 1,4-dichlorobenzene it was air stripping. Figure 17 indicates the variation of the latter with time at the various sampling locations. Low

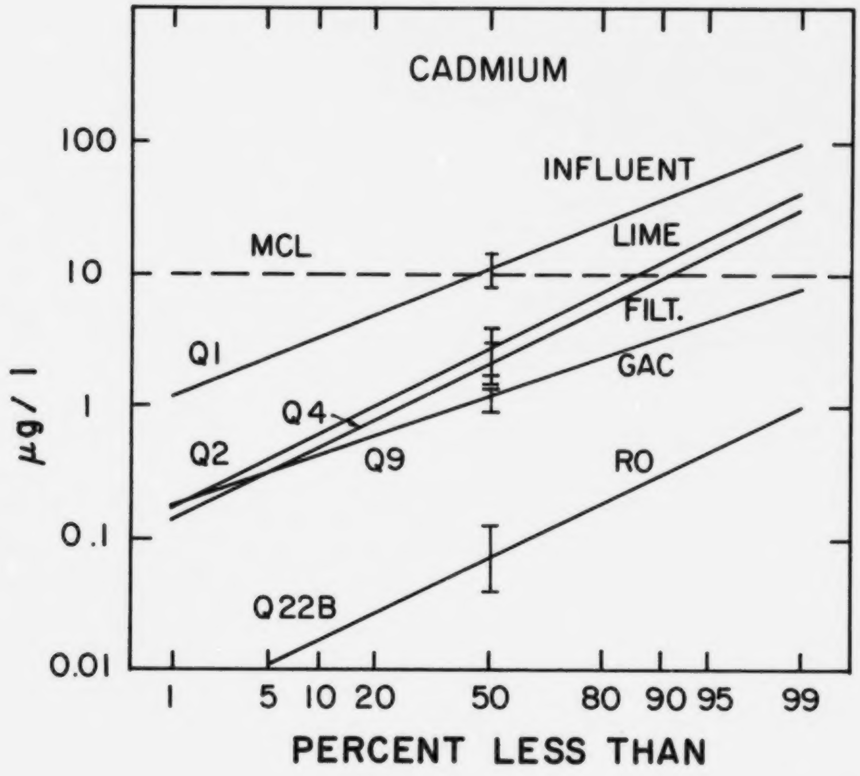


Figure 14. Frequency distribution for cadmium at various sampling locations.

TABLE 11. INFLUENT CONCENTRATIONS (Q1) FOR ORGANIC PRIORITY POLLUTANTS

Compound	No. Samples	Geom. Mean, M µg/l	95% Conf. Inter.	Spread Factor S
Chloroform	99	3.5	3.1-3.9	1.84
Bromodichloromethane	98	0.46	0.42-0.50	1.57
Dibromochloromethane	100	0.71	0.65-0.78	1.55
Bromoform	96	0.46	0.39-0.53	1.99
1,1,1-Trichloroethane	99	4.8	4.0-5.8	2.65
Trichlorethylene	99	1.1	0.9-1.3	2.87
Tetrachloroethylene	101	3.6	2.9-4.5	2.97
Carbon Tetrachloride	99	0.05	0.04-0.06	2.18
Chlorobenzene*	110	0.13	0.10-0.16	3.09
1,3-Dichlorobenzene	108	0.25	0.21-0.29	2.29
1,4-Dichlorobenzene	109	1.9	1.7-2.1	1.64
1,2-Dichlorobenzene	110	0.74	0.61-0.89	2.65
1,2,4-Trichlorobenzene	110	0.31	0.25-0.38	2.85
Napthalene	109	0.11	0.08-0.16	4.39
Ethylbenzene	99	0.04	0.03-0.05	3.52
2,4-Dichlorophenol	23	0.16	0.03-0.99	9.28
2,4,6-Trichlorophenol	23	0.13	0.04-0.41	6.50
Pentachlorophenol	23	1.23	0.58-2.6	4.16
PCB (Aroclor 1242)	86	0.40	0.32-0.49	2.27
Lindane*	86	0.11	0.10-0.12	1.55
DDT*	86	0.01	0.00-0.02	7.74
Di-n-butyl Phthalate	29	0.94	0.59-1.5	3.10
Diethyl Phthalate	29	1.14	0.35-3.7	10.2
Bis(2-ethylhexyl) Phthalate	29	11	5-27	9.5
Isophorone	13	0.30	0.04-2.3	14.7

* Concentration equal to or less than value shown.

TABLE 12. ORGANIC PRIORITY POLLUTANTS DETECTED IN INFLUENT (Q1) ON OCCASION BUT NOT QUANTITATIVELY EVALUATED

Compound	No. Samples Analyzed	No. Times Detected	Detection Limit µg/l	Max. Conc. Found µg/l
Phenanthrene	29	1	0.02	0.06
Anthracene	29	1	0.02	0.03
Fluoranthene	29	1	0.02	0.04
Pyrene	29	1	0.02	0.05
Butylbenzyl Phthalate	29	5	0.1	38
Di-n-octyl Phthalate	28	3	0.1	0.4
Phenol	13	1	0.05	12

TABLE 13. CONCENTRATIONS BEFORE GAC TREATMENT (Q6) FOR ORGANIC PRIORITY POLLUTANTS

Compound	No. Samples	Geom. Mean, M μg/l	95% Conf. Inter.	Spread Factor S
Chloroform	57	7.9	6-11	3.02
Bromodichloromethane	56	3.9	3-6	4.22
Dibromochloromethane	57	2.1	1.3-3.3	5.62
Bromoform	55	0.9	0.6-1.3	3.37
1,1,1-Trichloroethane	56	0.17	0.1-0.3	5.35
Trichloroethylene	44	0.04	0.01-0.25	14.60
Tetrachloroethylene	55	0.14	0.11-0.19	2.67
Carbon Tetrachloride	57	0.10	0.07-0.14	2.69
Chlorobenzene*	55	0.13	0.1-0.16	2.33
1,3-Dichlorobenzene	56	0.03	0.02-0.04	3.38
1,4-Dichlorobenzene	55	0.14	0.11-0.17	2.10
1,2-Dichlorobenzene	55	0.09	0.06-0.13	3.80
1,2,4-Trichlorobenzene	55	0.06	0.04-0.09	2.86
Napthalene	56	0.13	0.08-0.19	4.14
Ethylbenzene	54	0.03	0.02-0.04	2.28
2,4-Dichlorophenol	10	0.01	0.00-17	12.0
2,4,6-Trichlorophenol	10	0.05	--	--
Pentachlorophenol	10	0.48	0.23-1.0	2.11
PCB (Aroclor 1242)	41	0.00	0.00-0.09	20.7
Lindane*	41	0.06	0.04-0.07	1.75
DDT*	40	0.05	--	--
Di-n-butyl Phthlate	15	0.41	0.15-1.2	4.73
Diethyl Phthalate	15	0.59	0.09-3.9	12.3
Bis (2-ethylhexyl) Phthalate	15	1.2	0.5-3.4	5.9
Isophorone	8	0.05	10^{-3}-1.9	24

* Concentration equal to or less than value shown.

concentrations at Q6 in 1978 reflect a brief period when the air stripping fans were operated for ammonia removal.

The trihalomethanes need separate consideration as they are formed whenever chlorination is practiced. Chlorine is sometimes contaminated with carbon tetrachloride and this is the likely reason for its general increase in concentration throughout the plant (Tables 11, 13, 14,). Figure 18 illustrates the total trihalomethane concentration as a function of time at various sampling locations. The Interim Primary Drinking Water Regulation

TABLE 14. CONCENTRATIONS AFTER GAC TREATMENT AND CHLORINATION (Q9) FOR ORGANIC PRIORITY POLLUTANTS

Compound	No. Samples	Geom. Mean, M µg/l	95% Conf. Inter.	Spread Factor S
Chloroform	70	10.2	8-12	2.23
Bromodichloromethane	69	4.4	3.3-5.9	3.31
Dibromochloromethane	70	2.8	2.1-3.6	3.29
Bromoform	66	0.8	0.6-1.1	3.13
1,1,1-Trichloroethane	69	0.18	0.12-0.26	4.41
Trichloroethylene	54	0.06	0.02-0.22	10.70
Tetrachloroethylene	70	0.71	0.56-0.9	2.73
Carbon Tetrachloride	67	0.21	0.16-0.26	2.65
Chlorobenzene*	71	0.07	0.05-0.09	3.05
1,3-Dichlorobenzene	71	0.01	0.00-0.04	15.9
1,4-Dichlorobenzene	71	0.04	0.03-0.06	3.18
1,2-Dichlorobenzene	71	0.05	0.03-0.08	4.07
1,2,4-Trichlorobenzene	70	0.01	0.00-0.02	15.2
Napthalene	72	0.03	0.02-0.05	4.65
Ethylbenzene	67	0.02	0.01-0.03	4.34
2,4-Dichlorophenol	10	<0.05	--	--
2,4,6-Trichlorophenol	10	<0.05	--	--
Pentachlorphenol	10	<0.05	--	--
PCB (Aroclor 1242)	54	<0.05	--	--
Lindane*	54	<0.05	--	--
DDT*	54	<0.05	--	--
Di-n-butyl Phthlate	27	0.24	0.12-0.46	4.25
Dietyl Phthalate	27	0.82	0.17-4.1	16.4
Bis(2-ethylhexyl) Phthalate	27	0.63	0.16-2.6	23.7
Isophorone	14	<0.05	--	--

* Concentration equal to or less than value shown.

MCL for the sum of the concentrations of chloroform, bromodichloromethane,dibromochloromethane, and bromoform is 100 µg/l. The concentrations measured were instantaneous values in grab samples and thus are not truly indicative of what the concentrations might be if the treated water were sent through a distribution system to consumers. With this important limitation, the data show that the instantaneous values do not exceed 100 µg/l at any point in the treatment system. Also, concentrations were generally higher prior to 1980 when the ammonia concentration was lower and the applied chlorine reached breakpoint concentrations. In general, the THM concentration in the filtered (Q6) and chlorinated (Q9) effluents were higher than in the plant influent due to chlorination. Lowest concentrations were achieved in RO

TABLE 15. REVERSE OSMOSIS EFFLUENT (Q22B) CONCENTRATIONS FOR ORGANIC PRIORITY POLLUTANTS

Compound	No. Samples	Geom. Mean, M µg/l	95% Conf. Inter.	Spread Factor S
Chloroform	94	1.8	1.6-2.1	2.16
Bromodichloromethane	93	0.7	0.6-0.9	2.82
Dibromochloromethane	93	0.7	0.6-0.95	3.24
Bromoform	93	0.3	0.2-0.45	3.76
1,1,1-Trichloroethane	94	0.05	0.03-0.09	9.13
Trichloroethylene	82	0.01	0.00-0.06	21.40
Tetrachloroethylene	93	0.06	0.04-0.09	3.37
Carbon Tetrachloride	92	0.06	0.05-0.07	1.58
Chlorobenzene*	61	0.07	0.05-0.09	2.83
1,3-Dichlorobenzene	62	0.01	0.01-0.02	2.70
1,4-Dichlorobenzene	63	0.02	0.02-0.03	2.47
1,2-Dichlorobenzene	63	0.03	0.02-0.04	2.42
1,2,4-Trichlorobenzene	63	0.01	0.01-0.02	3.50
Napthalene	63	0.06	0.05-0.08	2.55
Ethylbenzene	58	0.04	0.03-0.05	2.53
2,4-Dichlorophenol	10	<0.05	--	--
2,4,6-Trichlorophenol	10	<0.05	--	--
Pentachlorophenol	10	<0.05	--	--
PCB (Aroclor 1242)	37	<0.05	--	--
Lindane*	35	<0.05	--	--
DDT*	37	<0.05	--	--
Di-n-butyl Phthalate	28	0.20	0.11-0.36	3.57
Diethyl Phthalate	28	0.32	0.05-2.11	31.40
Bis(2-ethylhexyl) Phthalate	28	1.2	0.4-3.8	14.6
Isophorone	16	<0.05	--	--

* Concentration equal to or less than value shown.

TABLE 16. CUMULATIVE PERCENTAGE REMOVALS FOR ORGANIC PRIORITY POLLUTANTS

Compound	Inf. Conc. g/1	Lime Q2	Air Strip Q4	Filt Q6	Chlor Q9	RO Q22B
1,1,1-Trichloroethane	4.8	26 (-3 to 46)	96 (95 to 97)	96 (94 to 98)	96 (94 to 98)	99 (98 to 99.4)
Trichloroethylene	1.1	19 (-13 to 42)	97 (91 to 99)	96 (80 to 99)	94 (82 to 98)	99 (95 to 99.8)
Tetrachloroethylene	3.6	21 (-12 to 44)	96 (95 to 97)	96 (95 to 97)	80 (73 to 86)	98 (97.5 to 98.9)
Chlorobenzene	0.13	-15 (-70 to 22)	15 (-20 to 41)	0 (-37 to 27)	46 (23 to 62)	46 (23 to 62)
1,3-Dichlorobenzene	0.25	28 (6 to 45)	88 (82 to 92)	88 (81 to 92)	96 (88 to 99)	96 (94 to 97)
1,4-Dichlorobenzene	1.9	28 (15 to 39)	90 (88 to 92)	93 (91 to 94)	98 (97 to 98.5)	99 (98.6 to 99.2)
1,2-Dichlorobenzene	0.74	22 (-8 to 43)	84 (76 to 89)	88 (81 to 92)	93 (89 to 96)	96 (94 to 97)
1,2,4-Trichlorobenzene	0.31	23 (-10 to 46)	61 (45 to 73)	81 (71 to 87)	97 (90 to 99)	97 (94 to 98)
Napthalene	0.11	-36 (-153 to 27)	-73 (-175 to -8)	-18 (-96 to 29)	72 (51 to 85)	45 (19 to 63)
Di-n-butyl Phthalate	0.94	78 (47 to 91)	81 (56 to 91)	NQ#	NQ	NQ
Lindane*	0.11	91 (42 to 99)	45 (30 to 57)	NQ	NQ	NQ

Values represent geometric mean percentage removal and 95 percent CI for the mean (brackets).

*Concentration equal to or less than value shown.

- NQ indicates concentrations too low for removals to be quantified.

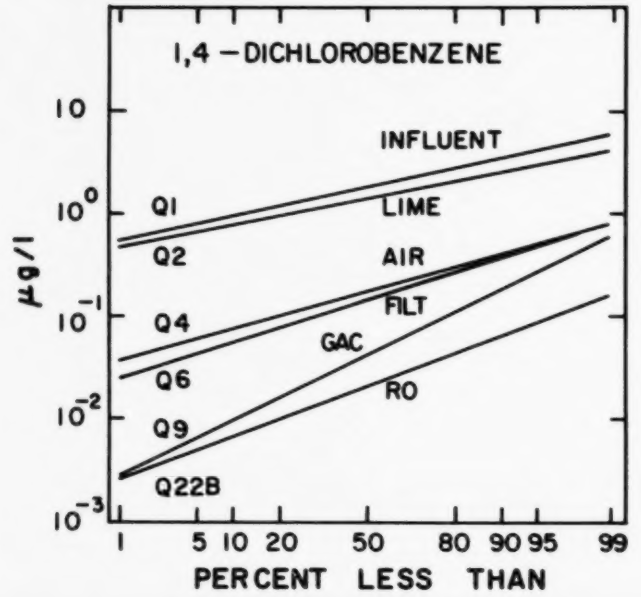


Figure 15. Frequency distribution for 1,4-dichlorobenzene concentrations at different sampling points.

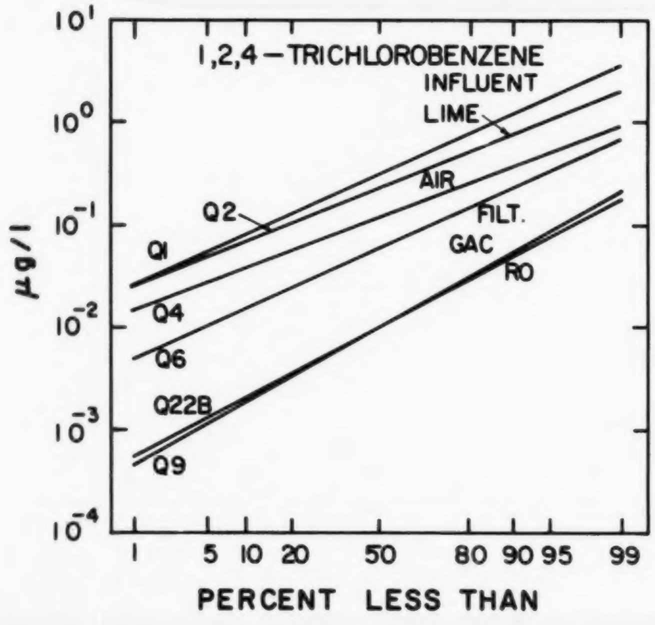


Figure 16. Frequency distribution for 1,2,4-trichlorobenzene concentration at different sampling points.

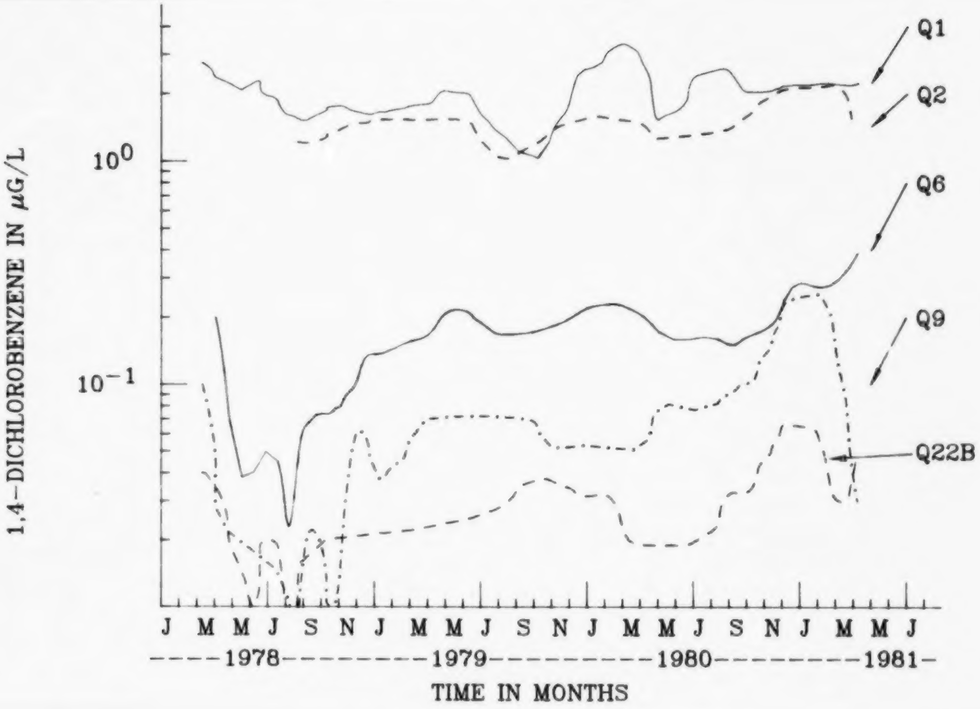


Figure 17. Variation in 1,4-dichlorobenzene concentration with time at various sampling locations.

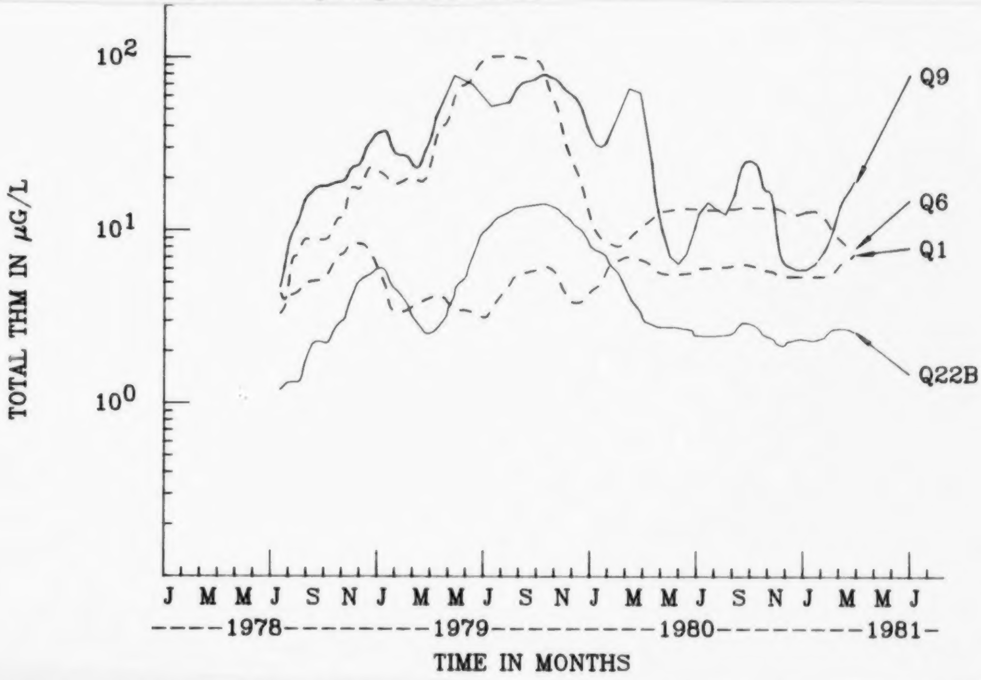


Figure 18. Variation with time of total trihalomethane concentration at various sampling points.

(Q22B) effluent as this received no chlorination and included stripping by the decarbonator. It is also true that the RO effluent (Q22B) contained smaller concentrations of THM precursors.

Figure 19 represents a summary of the geometric mean concentration for priority pollutants and the concentrations which were exceeded 5 percent of the time in the chlorinated (Q9) effluent as calculated from log normal static about 5 percent of the time a few others exceeded this level. Most organic priority pollutants remained at concentrations well below this level indicating both their low concentration in the influent water and/or the effectiveness of the treatment train in their removal.

Priority Pollutant Summary

This summary of data on the efficiency and reliability of WF21 in removing priority pollutants indicates several factors of interest. First, the concentration of priority pollutants in the secondary effluent treated were summarized elsewhere. The potential significance of these compounds needs to be addressed.

Because of the relatively low influent concentrations to WF21 and the effectiveness of the combination of processes present, effluent concentrations of priority pollutants tended to be very small. Only the trihalomethanes exceeded 1 μg/l on the average. The concentrations of most other priority pollutants were generally below the detection limit. About 5 percent of the time other compounds such as the chlorinated ethanes and ethylenes exceeded 1 μg/l in the GAC chlorinated effluent and a few other compounds approached the 1 μg/l level. Whether such concentrations have any significant health implications is not presently known.

Priority Pollutant Removal Conclusions

1. Concentrations of the priority pollutants measured in Orange County segregated and secondary treated municipal watewater were low, with few compounds exceeding 1 μg/l or drinking water MCL levels.

2. The processes used at WF21 were effective in reducing the concentrations significantly, and in many cases well below detection limits.

3. Lime and RO treatment were the most effective processes for removal of inorganic priority pollutants.

4. The organic priority pollutants present in quantifiable concentrations were removed primarily by air stripping, GAC treatment, and RO treatment; the particular removals obtained for a given compound depended upon the chemical characteristics of the compound.

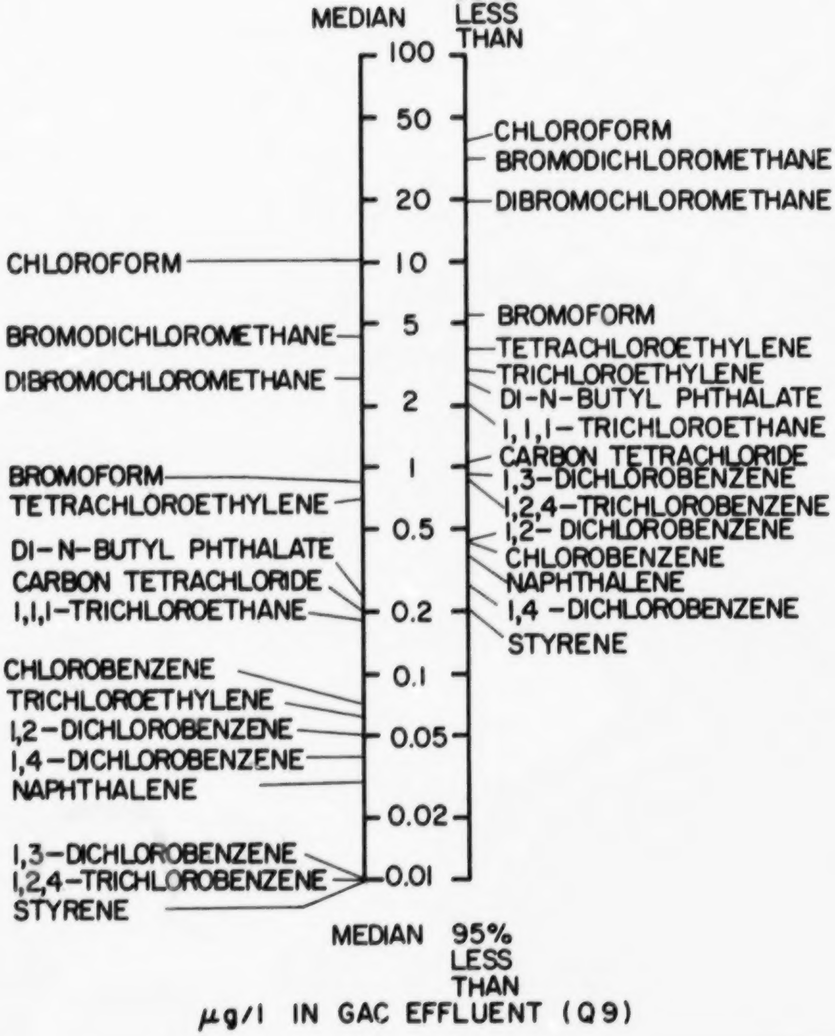


Figure 19. Geometric mean (shown as median) and calculated 95 percent less than values for organic priority pollutants after GAC treatment and chlorination (Q9).

NON-PRIORITY ORGANIC POLLUTANTS

A range of organic compounds not presently on the priority pollutant list were also measured during the period after January 1980. It was felt to be important to identify these compounds to the extent feasible and to determine their removal by the WF21 processes. This may help in understanding the removal capabilities of the processes in general, and might serve to identify the characteristics of organic compounds that make them susceptible to removal by different processes. Also, it would provide a better understanding of the nature of organic materials remaining in reclaimed wastewater. A detailed summary of analytical results for these compounds is contained in Appendices C and D. Only a brief summary is given here.

Compounds which were identified only tentatively and those which remained unidentified were referenced with a code name. Code names and tentative identifications are listed in Table 17 along with the main characteristics of the mass spectra. Included are the mass to charge ratio (m/z) and relative intensity (%) of the four most intense fragments and the parent ions (M^+). All non-priority organic pollutants were quantified as the standard added, i.e., it was assumed that the response factors for the compounds and the standards were the same. Compounds of the A/P fraction were quantified as d-lo-anthracene, compounds of the B/N fraction as 3,6-dimethylphenanthrene. Because of differences in extraction efficiency and detector response, the concentrations given are not accurate. They represent order of magnitude estimates only. The data can be used for determining removal efficiencies, however.

Table 18 contains a summary of the geometric mean concentrations for selected non-priority pollutants at the various sampling locations.

The estimated geometric mean concentration of many of the non-priority pollutants in the WF21 influent was below 1 µg/l, and indeed for a good number, the concentration was near the analytical detection limit. However, for some the concentration was sufficiently high so that the efficiency of removal by different processes could be calculated. Table 19 contains calculated cumulative percentage removals for these compounds between the influent and various sampling points in the treatment system. In general, for the overall treatment system (Q1 through Q9) without RO, removals exceeded 95 percent except for the fatty acids. No increase in removal could be detected by passage through RO, but concentrations here were too low for good quantification.

It is evident from the data in Table 19 that the overall efficiency of removal of many compounds increased significantly by passage through GAC treatment. The data in Table 20 show percentage removals obtained by GAC treatment alone for compounds for which sufficient data were available. Shown are percentage removals across the GAC columns alone and together with chlorination or RO treatment. For these compounds, GAC treatment removed at least 85 percent, and for some better than 99 percent. These compounds were removed more efficiently than COD (67 percent) or TOC (60 percent) during this period of operation. WF21 proved to be an efficient system for removal of all the non-priority organic pollutants measured, except perhaps for some of the fatty acids. It is not clear why these latter compounds were not removed more

TABLE 17. MASS TO CHARGE RATIO (m/z) OF THE FOUR MOST INTENSE PEAKS, INTENSITY, AND APPARENT MOLECULAR ION OF NON-PRIORITY POLLUTANTS FOR WHICH IDENTIFICATION WAS NOT POSITIVE BY GC/MS

CODE[a]	TENTATIVE IDENTIFICATION	Four Most Intense Peaks m/z (Intensity,%)				Molec. Ion M+ (Intensity, %)[b]
BASE/NEUTRALS						
X4	4-Hydroxy-4-Methyl-2-Pentanone (Diacetone Alcohol)	43 (100)	59 (43)	58 (24)	101 (21)	
X11	1-2-(2-Methoxy-1-Methyl-Ethoxsy)-1-Methylethoxy-2-Propanol	59 (100)	73 (40)	45 (23	117 (21)	
X12	Aliphatic Hydrocarbon, unsaturated?	43 (100)	71 (91)	56 (39)	41 (34)	
X13	Related to X 13	43 (100)	71 (76)	56 (64)	89 (39)	
X15	Aliphatic Hydrocarbon, unsaturated?	55 (100)	41 (100)	67 (67)	82 (61)	
X16	Aliphatic Hydrocarbon	57 (100)	71 (73)	43 (63)	41 (26)	
X18	Alkylbenzene	91 (100)	147 (27)	41 (15)	43 (13)	
X19	Aromatic?	151 (100)	77 (72)	105 (58)	94 (32)	
X21	Unknown	58 (100)	43 (8)	41 (6)	59 (4)	
X22	Unknown	57 (100)	45 (87)	41 (51)	85 (39)	
X23	Cholestane Derivative?	43 (100)	55 (70)	41 (54)	81 (52)	388 (2.9)
PEGAPE4[c]	Octylphenol Diethoxylate	43 (100)	135 (89)	57 (43)	223 (8)	294 (3.1)
Oxazolidinone	3-(2-Hydroxypropyl)-5-Methyl-2-Oxazolidinone	42 (100)	74 (99)	115 (87)	41 (87)	159 (-)
Benzothiazole	2(Methylthio)-Benzothiazole	181 (100)	148 (69)	108 (27)	180 (19)	
ACID/PHENOLS						
	Resin Acid A	146 (100)	121 (28)	114 (26)	59 (26)	
	Resin Acid B	146 (100)	43 (42)	59 (40)	114 (32)	
117A	Alkylphenol Polyethoxy Carb. A	117 (100)	59 (100)	57 (86)	41 (58)	
117F	Alkylphenol Polyethoxy Carb. F	59 (100)	117 (74)	45 (45)	135 (23)	
117H	Alkylphenol Polyethoxy Carb. H	59 (100)	117 (68)	45 (38)	41 (25)	

[a] = Code name used in tables.

[b] = Parent Ion

[c] = PEGAPE4 and 117-compounds have not been characterized previously. PEGAPE4 has spectrum similar to those of nonylphenol polyethoxylated (W. Giger, E. Stephanou, and Ch. Schaffner, Chemosphere, 10, 1253(1981).

efficiently. However, they are components of all living things and may have been released into the water to some extent during treatment by death of microorganisms from disinfection or as a result of bacterial growth such as in the GAC columns. Their ubiquitous occurrences also makes their analysis problematic. The data indicate that for the fatty acids, chemical precipitation appeared to be the main removal mechanism (Table 19).

TABLE 18. GEOMETRIC MEAN CONCENTRATIONS FOR NON-PRIORITY ORGANIC POLLUTANTS

	Geometric Mean Concentration, μg/l						
Compound	Inf Q1	Chem Eff Q2	Strip Eff Q4	Filt. Eff Q6	GAC Eff Q8	Chlor Eff Q9	RO Eff Q22B
p-Xylene	0.01	0.04	0.02	0.02	0.02	0.01	0.03
m-Xylene	0.05	0.12	0.07	0.07	0.04	0.03	0.07
Heptyldehyde	0.06	0.04	0.02	0.12	0.02	0.03	0.01
Styrene	0.04	0.04	0.04	0.04	0.01	0.01	0.03
2-Methyl-Napthalene	0.02	0.02	0.02	0.02	0.01	0.00	0.01
1-Methyl-Napthalene	0.01	0.02	0.03	0.02	0.01	0.00	0.01
Heptylcyanide	0.00	0.01	0.01	0.02	< 0.01	0.00	0.00
Acenapthylene	0.00						
Tributylphosphate	5.00	3.60	3.05	1.48	0.15	0.23	0.34
Oxazolidinone	1.44	0.34	0.06	12.9	0.07	1.52	0.03
Caffeine	3.59	1.87	1.75	2.02	0.00	< 0.1	0.15
Benzothiazole	0.20	0.21	0.14	0.20	< 0.1	< 0.1	< 0.1
Lauric Acid	6.20	2.37	4.64	3.03	0.49	1.66	0.57
3-Hydroxy Lauric Acid	2.81	0.50	1.20	3.23	0.25	0.25	< 0.5
Myristic Acid	8.69	6.30	7.12	6.25	4.96	4.87	3.78
Palmitic Acid	27.7	11.4	14.9	12.6	18.9	12.2	10.1
Pentadecanoic Acid	1.40	0.64	0.30	0.95	1.45	1.03	0.42
Stearic Acid	15.8	4.46	6.12	4.58	5.33	5.95	3.43
Clofibric Acid	5.59	4.45	3.45	3.58	0.36	0.00	0.00
PEGAPE4	2.69	2.26	1.98	1.54	< 0.1	< 0.1	0.06
Resin Acid A	0.18	1.08	1.72	1.30	0.34	< 0.5	< 0.5
Resin Acid B	0.17	1.59	3.26	0.22	0.83	0.03	< 0.5
2,4,6 TCA	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
PCA	0.75	0.35	0.27	0.20	< 0.3	< 0.3	< 0.3
X4	0.07	0.00	< 0.1	0.00	< 0.1	0.01	0.08
X11	7.39	5.66	5.38	3.34	0.20	0.02	< 0.1
X12	0.11	< 0.1	< 0.1	0.04	0.03	0.01	< 0.1
X13	0.20	0.01	< 0.1	0.02	< 0.1	0.00	< 0.1
X15	0.12	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
X16	0.07	< 0.1	0.00	< 0.1	< 0.1	< 0.1	< 0.1
X18	0.19	< 0.1	< 0.1	0.06	< 0.1	< 0.1	< 0.1
X19	4.42	2.30	2.50	1.02	0.02	0.09	0.05
X21	0.01	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
X22	4.13	3.54	2.76	4.83	0.04	0.05	0.10
X23	0.01	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
117A	14.57	7.16	14.27	17.47	0.23	0.02	0.07
117F	3.67	4.65	4.14	2.20	0.34	0.01	0.00
117H	4.21	4.99	6.91	4.38	0.33	0.00	< 0.5

TABLE 19. CUMULATIVE REMOVAL EFFICIENCY FOR SELECTED NON-PRIORITY ORGANIC POLLUTANTS

	Percentage Removals*					
Compound	Lime Eff Q2	Strip Eff Q4	Filt Eff Q6	GAC Eff Q8	Chlor Eff Q9	RO Eff Q22B
Tributylphosphate	28 (-70 to 70)	39 (-41 to 75)	70 (-6 to 92)	97 (78 to 99.6)	95 (84 to 99)	93 (83 to 97)
Caffeine	48 (-81 to 85)	51 (-50 to 84)	44 (-78 to 82)	99.9 (76 to 100.0)	97.2 (11 to 99.9)	95.8 (87 to 98.6)
Lauric Acid	62 (-27 to 89)	25 (-94 to 71)	51 (-38 to 83)	92 (58 to 99)	73 (41 to 88)	91 (69 to 97)
3-Hydroxy-Lauric Acid	82 (-17 to 97)	57 (-66 to 89)	-15 (-380 to 73)	91 (64 to 98)	91 (70 to 97)	82 ?
Myristic Acid	28 (-80 to 71)	18 (-90 to 65)	28 (-47 to 65)	42 (-21 to 73)	44 (4 to 67)	57 (17 to 77)
Palmitic Acid	59 (-4 to 84)	46 (-38 to 79)	55 (8 to 78)	33 (-45 to 69)	56 (16 to 77)	64 (23 to 83)
Stearic Acid	72 (31 to 89)	61 (3 to 85)	71 (43 to 85)	66 (12 to 87)	62 (33 to 79)	78 (53 to 90)
Clofibric Acid	20 (-74 to 64)	38 (-46 to 74)	36 (-88 to 78)	94 (1 to 99)	>99.9 ?	99.9 (92 to 100.0)
PEGAPE4	16 (-1200 to 95)	26 (-161 to 79)	43 (-223 to 90)	96 ?	96 ?	98 (88 to 99.6)
X11	23 (-134 to 75)	27 (-93 to 73)	55 (-56 to 87)	97 (84 to 99.5)	99.7 (96 to 99.9)	98.6 (22 to 99.9)
X19	48 (-67 to 48)	43 (-57 to 80)	77 (4 to 94)	99.5 (81 to 99.9)	98 (92 to 99)	98.9 (95 to 99.8)
X22	14 (-325 to 83)	33 (-165 to 83)	-17 (-360 to 70)	99 (66 to 99.97)	98.8 (89 to 99.9)	97.6 (89 to 99.5)
117A	51 (-37 to 82)	2 (-136 to 59)	-20 (-180 to 49)	98 (85 to 99.8)	99.9 (98.9 to 100.0)	99.5 (97.6 to 99.9)
117F	-27 (-265 to 56)	-13 (-233 to 62)	40 (-69 to 79)	91 (61 to 98)	99.7 (92 to 99.99)	99.9 (95 to 100.0)

*Values represent geometric mean percentage removal and 95 percent CI for the mean (brackets).

TABLE 20. Removal Efficiency for Non-Priority Organic Pollutants by GAC and RO

Compound	Percentage Removals		
	GAC Alone (Q6 to Q8)	GAC Plus Chlor (Q6 to Q9)	GAC Plus RO (Q6 to Q22B)
Tributylphosphate	89 (-3 to 99)		
Lauric Acid	84 (4 to 97)	45 (-52 to 80)	81 (22 to 95)
3-Hydroxy-Lauric Acid	92 (61 to 98)	92 (68 to 98)	85 (-650 to 99.7)
Clofibric Acid	90 (-104 to 99.5)	> 99.9 ?	> 99.9 (81 to 100.0)
X11	94 (56 to 99)		
X19	99 (-17 to 99.97)	91 (41 to 99)	95 (64 to 95)
X22	99.2 (66 to 99.98)	99.0 (89 to 99.9)	97.9 (88 to 99.6)
117A	99 (86 to 99.9)	99.9 (99.0 to 100.0)	99.6 (98 to 99.9)
117F	85 (27 to 97)	99.5 (85 to 100.0)	99.8 (89 to 100.0)

*Values represent geometric mean percentage removal and 95 percent CI for the mean (brackets).

SECTION 8

CHEMICAL INDICATORS, SURROGATES, AND COLLECTIVE PARAMETERS

INTRODUCTION

There is a need to have good monitoring methods to evaluate the day to day performance of a wastewater reclamation plant, to become aware of sudden changes in the quality of influent water, and to detect the failure of a treatment process. Rapid evaluation of such changes would allow the operator to stop plant operation or divert poor quality water, and thus prevent contamination of the reused water distribution system. Ideally, monitoring of water quality parameters used to detect such changes could be continuous through use of instrumental methods so that undesired events could be detected as soon as they occur (18).

An additional difficulty in the routine operation of a wastewater reclamation plant is the high cost of measuring the wide range of chemical, biological, and physical parameters as conducted in this study. It would be desirable to have a few indicator chemicals that could be monitored relatively inexpensively and reliably to use as surrogates for other contaminants of interest that are more costly or difficult for analysis. An example of such a surrogate is the coliform analysis which is used to indicate the possible presence of fecal contamination and the efficiency of disinfection processes.

During this study, many individual pollutants and collective parameters were monitored. In this section an evaluation is made of the potential that several of these analyses have for monitoring treatment performance or serving as surrogates for other pollutants.

INDICATOR CHEMICALS

A good indicator chemical is one which is always present in the influent water in sufficiently high concentration, can be routinely monitored without great expense, and of which removal performance by the treatment system can be used to indicate the performance of a range of other chemicals. Tables 21 through 24 represent summaries of individual chemicals that were removed to a statistically significant degree by individual treatment processes.

For example, Table 21 lists chemicals for which removal by lime treatment was statistically significant over the period of this study. Heavy metals were the only chemicals measured that fell in this category. Thus if one were to select an indicator chemical to evaluate the performance of lime teatment, one or more of the heavy metals listed in Table 21 would likely be selected for this purpose. Another desired characteristic of an indicator chemical is

TABLE 21. STATISTICALLY SIGNIFICANT POLLUTANT REMOVALS BY LIME TREATMENT COMPARED WITH OVERALL REMOVAL JANUARY 1980 TO APRIL 1981

Pollutant	Geom. Mean Inf. Conc. μg/l (Q1)	Spread Factor S	Detect. Limit μg/l	Percentage Removal: Lime (Q1 to Q2) Mean	Percentage Removal: Lime (Q1 to Q2) 95% CI	Percentage Removal: Overall (Q1 to Q8) Mean	Percentage Removal: Overall (Q1 to Q8) 95% CI
Barium	94	1.71	1	62	50-71	59	42-71
Cadmium	9	2.36	0.1	80	68-87	85	77-91
Chromium	33	1.65	1	76	67-83	88	82-92
Copper	49	1.70	1	81	74-86	89	84-92
Iron	114	1.68	1	84	77-88	76	69-81
Lead	5	2.06	1	89	63-97	89	60-97
Manganese	56	1.49	0.1	98	96-99	94	90-96
Nickel	77	1.70	1	65	56-71	79	74-83
Silver	2	1.95	0.1	76	62-85	78	63-87

TABLE 22. STATISTICALLY SIGNIFICANT POLLUTANT REMOVALS BY REVERSE OSMOSIS* JANUARY 1980 TO APRIL 1981

Pollutant	Geom. Mean Inf. Conc. μg/l (22A)	Spread Factor S	Detect. Limit μg/l	Percentage Removal (Q22A to Q22B) Mean	Percentage Removal (Q22A to Q22B) 95% CI
Barium	35	2.04	1	97	95-98
Cadmium	1.6	3.11	0.1	96	91-98
Chromium	2.4	2.34	1	65	25-84
Copper	8.9	1.57	1	56	39-68
Iron	38	2.25	1	93	86-96
Lead	4.1	1.54	1	84	67-92
Manganese	2.5	2.45	0.1	91	74-97
Mercury	0.7	1.83	0.5	65	56-71
Nickel	24	1.86	1	76	62-85
Silver	0.4	3.38	0.1	63	15-84

*Including decarbonation.

TABLE 23. STATISTICALLY SIGNIFICANT POLLUTANT REMOVALS
BY AIR STRIPPING
MARCH 1978 TO APRIL 1981

Pollutant	Geom. Mean Inf. Conc. µg/l (Q2)	Spread Factor S	Detect. Limit µg/l	Percentage Removal (Q2 to Q4) Mean	Percentage Removal (Q2 to Q4) 95%CI
VOA Compounds					
Chloroform	4.7	1.35	0.05	81	75-86
Bromodichloromethane	0.8	1.53	0.05	91	87-94
Dibromochloromethane	0.9	1.55	0.1	81	76-85
Bromoform	0.6	2.21	0.2	67	51-78
1,1,1-Trichloroethane	3.6	2.49	0.05	95	93-97
Trichloroethylene	0.9	2.65	0.05	97	89-99
Tetrachloroethylene	2.9	2.90	0.05	95	93-97
CLSA Compounds					
1,2-Dichlorobenzene	0.6	2.44	0.01	79	68-87
1,3-Dichlorobenzene	0.2	2.02	0.01	83	74-89
1,4-Dichlorobenzene	1.4	1.59	0.01	87	83-89
1,2,4-Trichlorobenzene	0.2	2.56	0.01	50	25-67
Ethylbenzene	0.07	2.89	0.01	43	15-61
p-Xylene	0.04	2.76	0.01	50	22-68

that its concentration and percentage removal not be too variable under ordinary conditions of operation so that a major change in influent quality or process performance could be detected. The spread factor and breadth of the 95 percent confidence interval for the percentage removal are indicators of such variability. It is also desirable that the influent and effluent concentrations for the chemical be well above the analytical detection limit. Finally, it would be desirable that the one process, lime treatment in this case, be the only process bringing about significant removal so that the efficiency of the process could be inferred from monitoring data for the total plant influent and effluent only. The data in Table 21 can be used to select chemicals that have these properties.

At WF21 RO treatment also removes heavy metals and so their removal by lime treatment cannot be inferred from RO effluent quality. Also at WF21 contamination with heavy metals results during final chlorination as already discussed. Therefore, in Table 21, only data for removal by lime treatment and between Q1 and GAC effluent (Q8) are compared.

The concentrations of chromium, lead, and silver are too near the detection limit to be good indicator chemicals. The variability of cadmium as determined by the spread factor is too great. For copper, iron, and nickel the differences in removal efficiency by lime treatment and through the overall plant are too large. These considerations reduce the list to two

TABLE 24. STATISTICALLY SIGNIFICANT POLLUTANT REMOVALS BY GRANULAR ACTIVATED CARBON

Pollutant	Inf. Conc. µg/l (Q6)	Spread Factor S	Detect. Limit µg/l	Percentage Removal (Q6 to Q8)	
				Mean	95%CI
VOA Compounds[a]					
Chloroform	7.9	3.02	0.05	56	3-80
Bromodichloromethane	3.9	4.22	0.05	76	18-93
Dibromochloromethane	2.1	5.62	0.10	80	9-96
CLSA Compounds[b]					
Chlorobenzene	0.16	2.78	0.01	69	24-87
1,2-Dichlorobenzene	0.25	2.20	0.01	88	76-94
1,3-Dichlorobenzene	0.04	2.91	0.01	75	2-94
1,4-Dichlorobenzene	0.19	1.77	0.01	89	81-94
1,2,4-Trichlorobenzene	0.07	3.39	0.01	86	57-95
Heptaldehyde	0.07	3.22	0.01	71	30-88
Styrene	0.05	3.10	0.01	80	46-93
Napthalene	0.23	3.45	0.01	61	17-82
1-Methylnapthalene	0.04	2.45	0.01	75	27-91
2-Methylnapthalene	0.04	2.89	0.01	75	27-91
A/P Compounds[b]					
Lauric Acid	3.0	3.24	0.05	84	4-97
3-Hydroxylauric Acid	3.2	2.75	0.05	92	61-98
117A	17	3.12	0.05	99	86-99.9
117F	2.2	3.70	0.05	85	27-97
B/N Compounds[b]					
X11	3.3	6.7	0.10	94	56-99
X22	4.8	7.0	0.10	99	66-99.98

[a] = Data for March 1978 to April 1981

[b] = Data for August 1980 to April 1981

chemicals, barium and manganese. These two also represent the upper and lower ranges of removal efficiencies obtained for the heavy metals, 62 and 98 percent, respectively. These data suggest that by monitoring the influent and GAC effluent for barium and manganese, the efficiency or removal of these and other heavy metals by lime treatment might be inferred.

Table 22 is a summary of data for compounds that were removed significantly by reverse osmosis. The concentrations of chromium, lead, mercury, and silver are too close to the detection limit to be used as indicator chemicals; individual samples frequently had concentrations less than the detection limit. The spread factor is too high for cadmium. The remaining five heavy metals: barium, copper, iron, manganese, and nickel, are possible candidates for indicator chemicals. Again barium and manganese appear on this list. However, both are removed with high efficiency by RO treatment, 97 and 91 percent, respectively. This suggests that either copper or nickel might be added to the list with 56 and 76 percent removals, respectively.

Table 23 is a summary of pollutants with significant removal by air stripping. In this case, all potential indicator chemicals are organic and determined analytically either by the VOA or the CLSA analysis. Using the same criteria as previously, the trihalomethanes should be eliminated as they are formed by chlorination during treatment, thus complicating the interpretation of plant effluent concentrations. The concentrations of trichloroethylene, 1,3-dichlorobenzene, 1,2,4-trichlorobenzene, ethylbenzene, and p-xylene are too close to the detection limit. This leaves four compounds for further consideration, 1,1,1-trichloroethane, tetrachloroethylene, 1,2-dichlorobenzene, and 1,4-dichlorobenzene.

VOA is less costly and time consuming than CLSA and is a good candidate for automation, thus the first two of the four chemicals above are good candidates for indicator chemicals. These two chemicals are removed to a smaller degree by subsequent treatment processes and thus also satisfy better an additional criterion. However, their percentage removals by air stripping are high. An advantage of the two chlorinated benzene compounds is that their percentage removals are less and thus may be more sensitive to changes in process operation. Thus, all four are still worthy of further consideration.

Table 24 represents a summary of the compounds for which removal by GAC was statistically significant. The poorest average removals and greatest variability in removal was shown by the trihalomethanes. As is well known, these compounds tend to break through activated carbon beds long before most other compounds. Percentage removals of THMs is generally good just after regeneration, but then removal rapidly deteriorates. The data shown in Table 24 alone are not sufficient for selecting an indicator chemical for GAC treatment. Before going further on this issue, presentation of data on collective parameters will be made.

COLLECTIVE PARAMETERS

General Usefulness

Analyses for several collective parameters were made during this study. Collective parameters are used to measure groups of compounds, and so changes in these parameters represent the sum total change of all the pollutants measured by the parameter. An advantage of collective parameters is that a single measurement can be made to determine collectively what is happening to many different compounds. A disadvantage is that removals of the individual compounds measured collectively may vary greatly. One of the objectives of this study was to determine how well changes in collective parameters reflected changes in the individual compounds.

Among the collective parameters determined were chemical oxygen demand (COD) and total organic carbon (TOC), both of which measure a significant portion of the organic material present. Total dissolved solids (TDS) and electroconductivity (EC) are collective measures of dissolved inorganic materials. Other collective parameters determined are total organic halogen (TOX), which measures the concentration of halogen attached to organic compounds; total organic nitrogen (TON), which measures the total concentration of nitrogen associated with organic compounds; ultraviolet absorbance (UVA), which is another measure of dissolved organic matter; and total trihalomethane formation potential (TTHMFP), which is a measure of the potential the organic matter present has of producing trihalomethanes upon chlorination.

Changes During Treatment

Table 25 is a summary of the changes in concentration of the above collective parameters as water flowed through the treatment processes at WF21. The Table 26 data represent a summary of ratios of the collective parameters to illustrate relative changes that occur after various degrees of treatment. For example, the relative TOC/COD ratio tends to increase with increase in degree of treatment. This might suggest that more reduced materials are selectively removed over more oxidized materials. To some extent this is probably true since oxidized materials tend to be more hydrophilic. However, the ratio of 0.85 for RO effluent is very high, too high for most organic compounds except perhaps formic acid and some nucleic acid bases such as guanine. It is also believed that the COD analysis is slightly low because the demineralized water blanks used in the COD analysis always contain a small amount of dissolved organic material, and the COD equivalent of this material is subtracted from the sample COD. Thus, the TOC probably better reflects the total organic content of samples with low organic concentrations.

The TOX/TOC ratio increases significantly following chlorination (Q6 and Q9), which is expected. It also increases following GAC treatment (Q8), which suggests that the halogenated organic materials are more hydrophilic than the non-halogenated organic material. The TTHMP/TOC ratio generally decreases following chlorination, as would be expected. However, the ratio tends to increase following chemical, GAC, and RO treatment. Thus, the precursors appear to be more hydrophilic than other organic materials in general.

The UVA/TOC ratio varies in quite a different fashion. It increases following chlorination. Unreported laboratory studies by OCWD have shown this increase to be a function of the chlorine addition. UVA increases significantly with increase in chlorine dose, up to the point of breakpoint chlorination. Beyond that point the UVA decreases. The ratio appears to increase following RO treatment, but to decrease following GAC treatment. These changes may reflect the relative susceptibility of UV absorbing compounds to these different forms of treatment. The results suggest that UVA is not a good substitute for TOC as an indicator of organic removal by advanced treatment processes.

The TON/TOC ratio increases after GAC and RO treatment, which also may indicate that nitrogenous organic compounds tend to be more hydrophilic than other organic materials.

TABLE 25. SUMMARY OF COLLECTIVE PARAMETER GEOMETRIC MEAN CONCENTRATIONS AND 95% CONFIDENCE INTERVALS AT VARIOUS SAMPLING POINTS JANUARY 1980 TO APRIL 1981

Collective Parameter	Inf. (Q1)	Chem. Eff. (Q2)	Air Eff. (Q4)	Filt. Eff. (Q6)	GAC Eff. (Q8)	Chlor. Eff. (Q9)	RO Eff. (Q22B)
COD (mg/1)	50.4 (47-54)	31.5 (29-34)	30.8 (29-33)	29 (27-31)	10.4 (7-16)	10.5 (8.7-12.8)	1.3 (1.0-1.8)
TOC (mg/1)	15.7 (14-18)	9.5 (8.3-10.8)	9.7 (8.8-10.6)	10.5 (8.9-12.5)	3.6 (1.8-7.2)	4.0 (2.9-5.4)	1.1 (0.8-1.6)
TOX (μg/1)	131 (117-148)	107 (88-131)	100 83-120)	173 (132-227)	86 (59-125)	111 (91-138)	24 (14-38)
TON (mg/1)	0.7 (0.48-1.01)	0.36 (0.21-0.63)	0.41 (0.25-0.67)	0.46 (0.25-0.83)	0.19 (0.13-0.29)	0.20 (0.15-0.27)	0.09 (0.06-0.14)
UVA (absorb)	0.19 (0.18-0.19)	0.14 (0.13-0.15)	0.14 (0.13-0.15)	0.17 (0.16-0.19)	0.029 (0.01-0.08)	0.09 (0.07-0.12)	0.12 (0.02-0.03)
TTHMFP (μg/1)	296 (189-465)	222 (98-502)	235 (104-531)	159 (70-358)	175 (70-437)	167 (98-284)	94 (39-230)

TABLE 26. COLLECTIVE PARAMETER RATIOS

Ratio	Inf. (Q1)	Chem. Eff. (Q2)	Air Eff. (Q4)	Filt. Eff. (Q6)	GAC Eff. (Q8)	Chlor. Eff. (Q9)	RO Eff. (Q22B)
TOC/COD	0.31	0.30	0.31	0.36	0.35	0.38	0.85
(TOX/COD) x 1000	2.6	3.4	3.2	6.0	8.3	10.6	18.5
(TTHMFP/COD) x 1000	5.9	7.0	7.6	5.5	16.8	15.9	72.3
(UV/COD) x 1000	3.8	4.4	4.5	5.9	2.8	8.6	15.4
(TON/COD) x 1000	14	11	13	16	18	19	69
COD/TOC	3.2	3.3	3.2	2.8	2.9	2.6	1.2
(TOX/TOC) x 1000	8	11	10	16	24	28	22
(TTHMFP/TOC) x 1000	6	7	8	6	17	16	72
(UV/TOC) x 1000	12	15	14	16	8	22	18
(TON/TOC) x 1000	45	38	42	44	53	50	82

Percentage Removal by Treatment

Table 27 contains a summary of the percentage removals of the collective parameters by different treatment processes where such removal was statistically significant at the 95 percent confidence level. Table 28 contains a similar summary for the overall treatment system, with and without RO treatment. In general, COD, TOC, and TON removals were similar. However the variability in average removal as indicated by the range of the 95 percent CI was much greater for TON than for TOC or COD. Both COD and TOC are good general parameters for indicating the removal of organic materials in general.

UVA was considered as a possible substitute for TOC or COD, but its use for this is not supported by the data in Table 27. The percentage removal by lime treatment was less than for COD or TOC, as UVA measures only soluble material. UVA was increased in the recarbonation basin and chlorine contact basin as a result of chlorination as already discussed. Its removal by GAC was much higher than for TOC and COD, perhaps as a result of removal of the UVA compounds formed during chlorination. In any event, trends in this parameter do not follow trends in TOC and COD, and thus UVA will not serve as a good substitute for TOC and COD.

The percentage removal of TOX was not statistically different from that of TOC or COD by GAC and RO treatment. However, it is formed upon chlorination while TOC and COD are not. Interestingly, the formation of TOX was statistically significant in the recarbonation basin, but not in the final chlorination basin. The data suggest that TOX was formed during the final chlorination, but the great variability of data makes this difficult to confirm.

TABLE 27. PERCENTAGE REMOVALS OF COLLECTIVE PARAMETERS BY INDIVIDUAL PROCESSES[a,b]

Collective Parameter	Lime (Q1 to Q2)	Recarb. (Q4 to Q6)	GAC (Q6 to Q8)	Chlor. (Q8 to Q9)	RO (Q8 to Q22B)
Organic					
COD	37 (31 to 43)		64 (48 to 75)		87 (80 to 92)
TOC	39 (29 to 49)		66 (32 to 83)		70 (39 to 85)
TON	49 (5 to 72)		53 (17 to 79)		53 (17 to 73)
UVA	26 (21 to 31)	-26 (-39 to -14)	83 (56 to 93)	-210 (-690 to -22)	
TOX		-73 (-135 to -28)	50 (24 to 67)		73 (51 to 85)
TTHMFP					
Inorganic					
TDS	6 (2 to 9)				92 (90 to 93)
EC					92 (91.5 to 92.4)

[a] = Removal listed only if significant at 95 percent confidence level.

[b] = Upper value is mean percentage removal, lower values in brackets represent 95 percent CI for mean.

No data are contained in Table 27 for removal of TTHMFP. The variability of the results is so great that it was not possible to demonstrate statistically that this parameter was changed significantly with the limited data obtained.

The data in Table 28 indicate the overall removals of the various organic collective parameters by the treatment system. Removals by the overall system without RO were statistically significant only for COD, TOC, TON, and UVA. Based upon lack of overlap of the 95 percent CI for the mean removals, the data again indicate the UVA would not be a good substitute for COD or TOC analyses. Because it is both formed and removed during treatment, changes in TOX by the overall plant without RO were not significant.

All collective organic parameters were removed to a significant degree by the entire treatment plant including RO. However, the removals of UVA, TOX, and TTHMFP were different statistically than for COD and TOC.

TABLE 28. OVERALL PERCENTAGE REMOVAL OF COLLECTIVE PARAMETERS[a,b]

Collective Parameter	Overall Except for RO Q1 to Q9	Overall With RO Q1 to Q22B
Organic		
COD	79 (74 to 83)	97 (96 to 98)
TOC	75 (65 to 81)	93 (90 to 95)
TON	71 (55 to 82)	87 (78 to 93)
UVA	52 (38 to 63)	88 (85 to 90)
TOX		82 (70 to 89)
TTHMFP		68 (19 to 88)
Inorganic		
TDS	6 (2 to 10)	92 (91 to 93)
EC	-4 (-8 to 0)	92 (91 to 92)

a = Removal listed only if significant at 95 percent confidence level.
b = Upper value is mean percentage removal, lower values in brackets represent 95 percent CI for mean.

Tables 27 and 28 also contain data for the collective parameters TDS and EC, which measure primarily the inorganic materials in water. Removals of materials represented by these parameters occurred primarily with RO treatment as expected. The percentage removal of each was essentially the same as was the 95 percent CI for the mean. Thus, either parameter would appear to be suitable as a monitor of RO performance.

Possible Surrogates for GAC Treatment

The collective parameters of COD and TOC have generally been used to serve as surrogates for the removal of trace organic compounds by GAC treatment. They have many of the advantages suggested for indicator compounds discussed in the introduction to this section. The percentage removals of most individual compounds as listed in Table 24 are greater than for COD or

TOC as listed in Table 27. The exception is chloroform. Thus, one might conclude that the percentage removal of trace organic compounds on the average is at least as good as for TOC or COD.

It is desirable to determine how trace organic removal follows the course of TOC and COD removal by a given GAC column with time following regeneration. This can be done by following the temporal changes in trace organic concentration in the GAC effluent at Q8 during the period sometime between January 1980 and April 1981 since a single GAC column was used to produce this effluent. Newly regenerated columns were started on 14 April 1980 and on 7 November 1980. Q8 concentrations for the range of constituents listed in Table 24 were followed to determine whether removals at the end of GAC column usage was poorer than just after the column was regenerated. The only chemicals for which this was found were the trihalomethanes as determined by VOA analysis. For all other compounds, effluent concentrations were not different statistically when the column was taken out of service for regeneration than when it was first placed into service.

Figure 20 illustrates the changes in COD, TOC, chloroform ($CHCl_3$) and dichlorobromomethane ($CHCl_2Br$) following regeneration. Increase in effluent concentration of COD and TOC occurred almost immediately after the columns were put into service following the two regenerations. Effluent concentrations of chloroform began to increase about 50 days after regeneration, and of dichlorobromomethane, about 25 days after that. The effluent concentrations of TOC and COD had about doubled when the chloroform regeneration and dropped to well below 50 percent at the time of regeneration.

Both COD and TOC are sensitive indicators of the change in performance of GAC, much more so than for any of the trace organic compounds that were measured individually in this study. These collective parameters thus provide the characteristics that a surrogate parameter should have. It would appear possible to select effluent concentrations for these parameters that would signal the need for regeneration in order to avoid predetermined concentrations of trihalomethanes, other trace organic compounds, or organic materials measured collectively in the effluent. Once a goal for treatment is established, then either TOC or COD might be used as a surrogate parameter to assure that treatment operation meets these goals, and to indicate when GAC regeneration is necessary.

Collective Parameter Summary

This analysis of collective parameters has indicated that TOC and COD are the best collective parameters of those measured to be used in evaluating the overall efficiency of advanced treatment systems for the removal of organic compounds in general. Both can be readily measured and have adequate precision and sufficient stability from variation to provide good interpretation of treatment results. Both can also be used to monitor the performance of GAC columns and can serve well here as surrogates for the removal of individual trace organic compounds. Their removal also parallels closely the removal for TON, although the variability in the removal of the latter compound is much greater. COD, however, tends to be less accurate at low organic concentrations than TOC. Thus, in general, the latter is preferred.

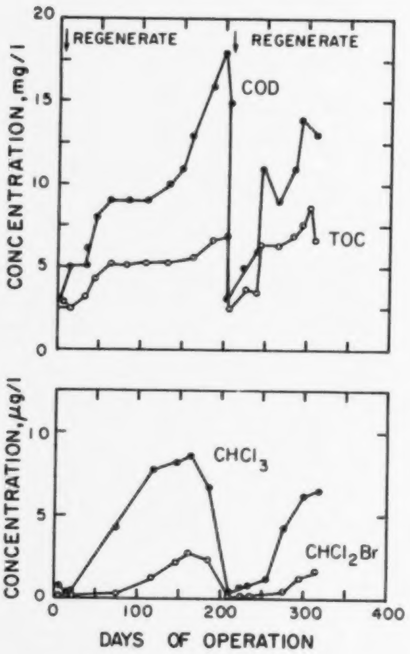


Figure 20. Performance of GAC following regeneration. Shown are effluent concentrations (Q8) for period from April 14, 1980 through April 7, 1981 (minus 40 days of shut-down).

UVA is not an adequate substitute for TOC or COD as it does not change in the same manner. It is formed upon chlorination and provides different removal statistics. Therefore, it should be used with great caution for monitoring organic removal, if at all.

TOX as a collective parameter for the total halogenated organic compounds present does not follow changes in TOC and COD, as generally expected. It is an independent measure and should be useful on its own to monitor the impact of disinfection processes on formation of halogenated compounds and other processes such as GAC and RO in removing them.

The analysis for TTHMFP used here produced results that were too variable to be used to monitor the efficiency of treatment processes or to adequately monitor any meaningful characteristics of effluent quality. The high ammonia concentration in the WF21 waters necessitated high chlorine dosages in the TTHMFP analysis in order to reach the break point at which THM's begin to form significantly. Changes in the mineral characteristics of water by RO treatment also changed the distribution of trihalomethanes formed in the TTHMFP analysis towards a higher percentage of chloroform. Thus, the TTHMFP analysis used here was not found to be a useful tool, at least within the context of this study.

SECTION 9

ASSAYS FOR MUTAGENIC ACTIVITY

INTRODUCTION

Perhaps the major issue associated with potable reuse of reclaimed wastewaters is the possible adverse effect on human health. In order to resolve this issue, toxicological testing is required. Testing and evaluating the potential health effects of mixtures of chemicals as found in reclaimed water is difficult and complex, and the time and resources necessary for such an evaluation were not available for this study. However, rapid *in vitro* methods have been used to indicate the mutagenic and carcinogenic potential of chemicals from a diversity of environmental sources. The degree of correlation between these tests and whole animal studies is reasonably high so that they have proven useful for initial screening for possible further toxicological testing. One part of the scope of this study was to use one of the simplest *in vitro* methods, the Ames assay for point mutation in *Salmonella typhimurium* (17). This relatively inexpensive assay allowed evaluation of many samples taken at various times from different locations within the WF21 reclamation plant. While results from the Ames test alone cannot be used to judge the safety of reclaimed water, they should be useful for making comparisons with other water supplies, and to help design studies for more definitive toxicological testing for water reclamation in the future.

In general, toxicological testing requires concentration of the chemicals in water in order to obtain a positive response. Concentration itself raises many questions that cannot be resolved at present. Concentrates obtained by existing procedures are not wholly representative of the original water sample. All concentration procedures are selective for certain classes of compounds while discriminating against others. Pooling of concentrates obtained with complementary concentration methods may reduce the problem of procedure selectivity to some degree. Because of the complexities involved in concentrating all organics from water, we have given emphasis to the characterization of mutagenic materials and did not attempt to reproduce representative concentrates. The concentrates were tested individually and characterized further when found to be positive. Because only an unknown fraction of all the organics were recovered and tested, no definite conclusions could be drawn with respect to the total of the mutagenic activity present. These limitations are significant and need to be recognized when the results of this preliminary study are reviewed.

MUTAGENIC TESTING

Background

Organic concentrates for mutagenic testing were prepared mainly by adsorption on XAD-8 (Rohm and Haas, Philadelphia, PA), but concentration by ion-exchange, ultrafiltration (UF), gaseous purging of volatiles, and continuous liquid-liquid extraction (CLLE) were also explored. The concentrates obtained were subjected to Ames testing at the Microbial Genetics Department at SRI International, Menlo Park, CA. When found positive (mutagenic) the concentrates were further fractionated by column chromatography and characterized in detail by GC/MS.

Sampling

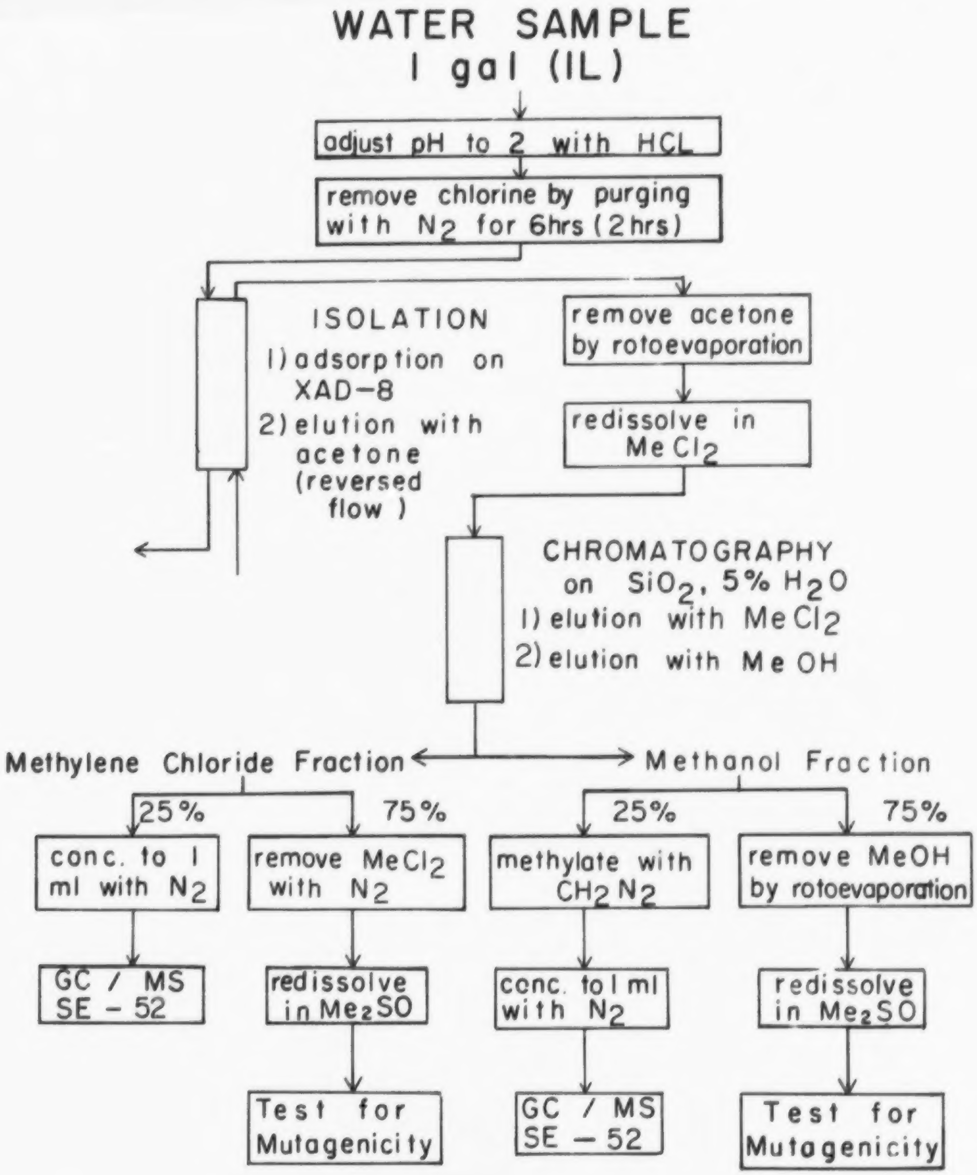
Composite samples were taken in 1-liter or in 1-gal glass bottles equipped with Teflon lined screw caps. Samples were taken at request by WF21 personnel and shipped by air freight in cooled containers to Stanford University. Generally, samples for mutagenicity testing and trace organic monitoring were taken at the same dates, but since extraction of the mutagenicity samples was more laborious and costly the sampling frequency was less for this analysis. Four locations were the maximum number sampled on any given day and a set of samples was generally collected every two to three weeks.

Concentration and Separation

Adsorption on XAD-8 with Acetone Elution--

The schematic of the concentration and fractionation procedure used is depicted in Figure 21. Samples were acidified to pH 2 with concentrated hydrochloric acid. After pH adjustment, the chlorinated 1-liter samples were purged with nitrogen for two hours and the 1-gal samples for six hours to remove free chlorine (22). Amberlite XAD-8 was purified as described by Leenheer and Huffman (16). The XAD-8 columns were packed in acetone using preparative chromatography columns (9x250 mm) (Altex, Berkeley, Ca 94710) to 20 mm below the top. After packing, one liter of water was passed through the columns, followed by two cycles of 100 ml 0.1 N hydrochloric acid and 0.1 N sodium hydroxide. After a final rinse with 100 ml water, the columns were ready for use.

The samples were forced through the columns from the sample bottles by means of high purity nitrogen and specially fabricated adapters. A nitrogen pressure of 10 psi resulted in a flow rate of approximately 8 ml/min. After passing the sample through the column, nitrogen was used to push the residual water out. Then an adjustable plunger was inserted into the column, and 50 ml acetone was pumped through in reversed direction by means of a one-stroke metering pump (Model IVEK, ALLTECH, Deerfield, Il 60015) at the rate of 1 to 2 ml/min. Acetone and residual water were removed from the extract by rotoevaporation at 50°C (thereby losing the volatiles). To divide the concentrate into portions for mutagenic testing and chemical characterization it was redissolved in 5 ml acetone (not shown in schematic).



WATER SAMPLE
1 gal (1L)
adjust pH to 2 with HCL
remove chlorine by purging with N2 for 6hrs (2hrs)
ISOLATION
1) adsorption on XAD-8
2) elution with acetone (reversed flow)
remove acetone by rotoevaporation
redissolve in MeCl2
CHROMATOGRAPHY on SiO2, 5% H2O
1) elution with MeCl2
2) elution with MeOH
Methylene Chloride Fraction
Methanol Fraction
25%
75%
25%
75%
conc. to 1 ml with N2
remove MeCl2 with N2
methylate with CH2N2
remove MeOH by rotoevaporation
GC / MS SE - 52
redissolve in Me2SO
conc. to 1 ml with N2
redissolve in Me2SO
Test for Mutagenicity
GC / MS SE - 52
Test for Mutagenicity

Figure 21. Concentration and Fractionation Scheme for Mutagenic Testing.

Silica Gel Chromatography--

Fractions of the extract intended for chemical characterization were evaporated to dryness and redissolved in 200 µl $MeCl_2$. The concentrate was then transferred to the top of a 0.5x10 cm silica gel column packed in $MeCl_2$. The silica (80-200 mesh, J. T. Baker, Phillipsburg, NJ 08865) was deactivated with 5% w/w water prior to use. A first fraction was eluted with 10 ml $MeCl_2$. After passing 2 ml of 25% MeOH in $MeCl_2$ through the column, a second 10 ml fraction was eluted with MeOH. The combined MeOH eluates constituted the second fraction. Both fractions were concentrated to 1 ml under a stream of nitrogen purified with a Gas Purifier (Alltech Associates, Arlington Heights, IL 60004). Typically 25% of each concentrate was set aside for GC/MS analysis. The remainder was evaporated to dryness, redissolved in DMSO and submitted for mutagenic testing.

Other Procedures--

After passing the sample through the XAD-8 column at pH 2 as described above, it was neutralized and pumped through a XAD-8 column a second time. Again the adsorbed organics were eluted with acetone. The eluate was concentrated to dryness, redissolved in DMSO and subjected to testing. The concentrates obtained this way were designated as neutral (N).

During adsorption at pH 2 (particularly in Q1 samples) colored brownish materials were accumulated at the top of the column that were not eluted with acetone. Following acetone elution, the column was eluted with 40 ml 0.1 N NaOH in an attempt to recover the strongly held materials. The basic eluate was neutralized and concentrated on a rotary evaporator under reduced pressure to approximately 0.5 ml. The concentrate was diluted with DMSO to 2 ml and subjected to Ames testing. The concentrates obtained this way were designated as basic (B). An experiment was made whereby 30 percent MeOH was added to the eluent but neither of these methods was completely successful in recovering all the colored materials. Apparently, XAD-8 was irreversibly adsorbing certain organic materials. A Q9 sample (5/22/80) was passed through an XAD-8 column at pH 10 to adsorb hydrophobic bases. The adsorbed fraction was eluted with 40 ml acetone followed by an elution with 40 ml 0.1 N HCl.

Hydrophilic acids and bases were concentrated using a strong cation exchange resin (AG-MP-50, Bio-Rad) and a weak anion exchange resin (Duolite A-7, Diamond Shamrock) as described by Leenheer (16). The AG-MP-50 resin was packed in a 9 x 150 mm liquid chromatography column (Altex, Berkeley, CA). The Duolite A-7 column was packed in a 25 x 250 mm column. After conditioning, which converted the cation exchanger into the hydrogen form and the anion exchange column into the free base form, the two columns were connected in series with the XAD-8 column first, the cation exchanger second, and the anion exchanger third (Figure 22). The samples were acidified to pH 2 and dechlorinated by the nitrogen purge method. For adsorption, the samples were forced through the three columns by means of nitrogen pressure which was applied to the sample bottles (Figure 22). After adsorption, the columns were disconnected and eluted individually, the AG-MP-50 columns with three bed volumes of 1 N NH_4OH and the Duolite A-7 column with three bed volumes of 3N NH_4OH. The AG-MP-50 eluate was concentrated to 2 ml by rotoevaporation under reduced

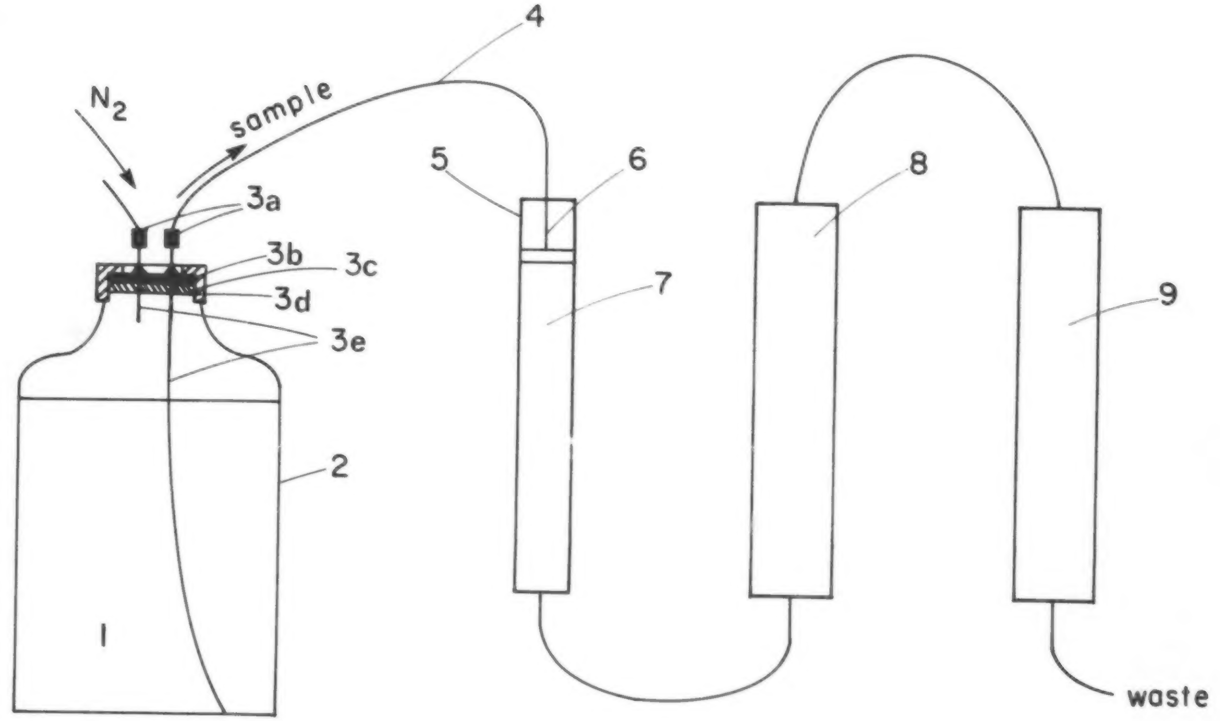


Figure 22. Arrangement of adsorption columns: (1) sample; (2) sample flask; (3) pressure adapter consisting of (3a) 1/8" SWAGELOCK fittings; (3b) stainless steel disk; (3c) screw-cap with hole; (3d) TEFLON seal; (3e) stainless steel tubes (1/8") welded to disk: (4) TEFLON tubing; (5) chromatography column; (6) plunger; (7) XAD-8 resin column; (8) cation exchanger column and (9) anion exchanger column.

pressure. The concentrated solution was separated from small amounts of precipitated salts with a pipet and diluted to 4 ml with DMSO. The Duolite A-7 eluate contained large amounts of NH_4Cl which precipitated during rotoevaporation. The crystals were removed by filtration. The 2 ml concentrate was diluted to 4 ml with DMSO and submitted for testing.

One gallon samples of Q6, Q8, Q9 (1/2/81) were concentrated by UF. First the samples were dechlorinated, then the pH was adjusted to 6. To concentate the high molecular weight fraction, the samples were passed through a 2-liter stirred cell (Amicon, Lexington, MA) equipped with a UM05 membrane which is specified to retain compounds with a molecular weight larger than 500. After concentrating the samples to 200 ml they were transferred to a 200 ml cell and further concentrated to approximately 30 ml.

An effort was made to test the mutagenicity of volatile materials. One-gallon samples of Q6, Q8 and Q9 were purged with nitrogen for two hours at a flow rate of approximately 1.5 l/min. The purge gas was passed through a trap made of U-shapped glass tubing which was immersed in a dry ice/150 iso-propanol mixture. The trapped gases (including water) were dissolved in 2 ml MeOH and subjected to Ames testing against TA100 in a dessicator.

Samples were concentrated with CLLE to verify whether the mutagens extracted with the standard XAD-8 procedure would also be present in the extracts routinely analyzed for trace organic compounds.

Mutagenic Analysis

The fractions intended for mutagenic analysis were submitted as solutions of one or two ml DMSO. Extracts were tested for mutagenicity at SRI International, Menlo Park, using the procedure developed by Ames, Yamasaki and McCann (17). Typically aliquots of 50, 100, 200, and 400 µl per plate (1 plate per aliquot) were applied. Negative controls were run with 100 µl DMSO. Positive controls without metabolic activation (MA) were run with sodium azide (NaN_3); positive controls with MA for TA100 were run with 2-anthramine and with 2-nitrofluorene for TA98. Initial blanks were run with MQ-water. Then procedural controls were obtained by extracting the precleaned XAD-8 columns with acetone. These extracts obtained from several columns were combined and tested along with the samples. An experiment was made in which distilled water containing 5 mg/l chlorine was passed through the columns without prior dechlorination in order to verify that residual chlorine did not produce mutagens during adsorption.

An extract was considered to be mutagenic (positive) when (i) a positive dose-response relationship was observed, and (ii) when the number of revertant colonies at the highest dose exceeded the average background value by at least 100%. The net revertant number (NR) was calculated by subtracting the average background value (determined with two to four plates with 100 µl DMSO added to each) from the number of revertant colonies observed. The NR concentration (NR/L) was calculated from the positive slope of the NR dose relationship by linear regression after considering appropriate concentration factors.

Special Analytical Techniques

GC/Triple Stage Quadrupole MS Analysis--

A Finnigan triple stage quadrupole (TSQ) MS was used to identify certain compounds found in concentrated extracts. This instrument was coupled to a Finnigan 9610 model GC. The GC was equipped with a 1.8 m column packed with 3% OV-1 on 60/80 mesh Chromosorb W A/W. A daughter ion experiment was performed with the first MS in the positive-electron impact (EI+) mode (19). For collision activated decomposition (CAD) the nitrogen pressure in the collision cell was adjusted to 2.35 mtorr; the collision energy was 12 V. A two µl extract was injected at 120°C, then the temperature was increased at a rate of 5°C/min to 250°C. Injector and interface were set at 250°C; the flow rate was 16 ml/min.

GC/High Resolution (HR) MS Analysis--

A MAT 711 instrument was used which was interfaced to a Hewlett-Packard 7610 A GC by means of a Watson-Bieman separator. The GC was equipped with a 1.8 m column (3.2 mm i.d.) packed with 3% OV-17 on Chromosorb Q 80/100 mesh. The resolution was 5000. The mass spectra were acquired from 500 amu downward to 40 amu at a rate of 8 seconds per decade. The extract (3 µl) was injected at 100°C, then the temperature was increased at a rate of 4°/min to 300°C.

Preparation of Brominated Alkylphenol Polyethoxy Carboxylate Test Mixture (BrAPECs)--

"t-octyl-phenol polyethoxylate" (3 moles ethylene oxide units (ETO) per molecule) was purchased from Chem Service, West Chester, PA 19380. For bromination approximately 400 mg of the alkylphenol polyethoxylate (APE) was dissolved in 20 ml glacial acetic acid. To this solution was added 160 mg elemental bromine dissolved in 5 ml glacial acetic acid (20). After letting the reaction mixture stand overnight, excess bromine was destroyed by adding 0.1 N sodium thiosulfate solution. Then 200 ml of water was added and the solution was extracted two times with 100 ml ether. The combined extracts were dried over anhydrous sodium sulfate, filtered and concentrated to about 10 ml. For oxidation, i.e. conversion of the alcohol into the corresponding carboxylic acid, 10 ml of Jones reagent (0.4 mol potassium dichromate in 700 ml 2 M sulfuric acid) was added to an APE and a BrAPE solution (21). The solution was warmed at 60° for 2 hrs, then diluted with 25 ml water and extracted two times with 50 ml ether. The combined extracts were washed three times with 100 ml water. After washing, the ether extract was dried, filtered and concentrated. Half of it was set aside for mutagenic analysis testing, the other was used for chemical characterization.

RESULTS

The net reversion rate per liter of sample (NR/L) was used to compare the mutagenic activity at different locations and in different fractions. To estimate data variability with respect to quantitative comparisons, the data obtained from running negative and positive controls were statistically evaluated. The average of all background reversion rates observed with 100 µl

DMSO was 110 (n = 48), the coefficient of variation was 26%. Data from plates run simultaneously were less variable. The standard deviation within a set deviated only 12 percent from the mean. A similar observation was made for the positive controls obtained with 1 μg NaN_3. When tested within a set, the standard deviation was 5 percent. However, the number of total reversions induced by NaN_3 fluctuated considerably over the study period. The mean value was 497, but the coefficient of variation was 32 percent. Therefore, caution must be exercised when data obtained at different times are compared.

The mutagenicity data of the XAD-8 concentrates is summarized in Appendix F. Q22B extracts were negative in all cases and only sampling dates are given. The data are summarized in Table 29. The data show that at Q1 activity against TA100 was detected in 40 percent of the samples tested. In the unfractionated extracts of Q8 and Q22B no activity was detected. At Q6 and Q9 samples were positive. The average activities followed the same trend. They were highest at Q6 and Q9 but zero at Q8 and Q22B. The increase at Q6 and at Q9 clearly indicates that chlorination produced mutagens. The activities measured with TA98 are consistent with TA100 data but less data were acquired with this strain. To illustrate these observations in more detail, selected data are shown in Tables 30 and 31 and discussed in the following.

The initial experiments were designed to establish a procedure suitable for routine monitoring. XAD-8 resin was used as the adsorbent and both TA98 and TA100 were used as tester strains. The effect of metabolic activation was tested with concentrates of samples from the plant influent (Q1) and from the two plant effluents (Q9 and Q22B). These data are summarized in Table 30.

The data suggest that the mutagens present in Q1, Q6 and Q9 were detectable with both strains TA100 and TA98. In contrast, the organics present in Q22B and in Q8 did not induce activity in either strain. Several characteristics of the mutagenicity observed were similar to those reported in chlorination-stage effluents of pulp mill effluents (22,23) and in chlorinated drinking water (24): The reversion rate was higher in TA100 than in TA98 and was reduced by MA. In TA100 the reduction was approximately 50 percent; in TA98 it was 100 percent.

To evaluate the impact of individual processes in more detail, concentrates from various stages of treatment were tested. MA was discontinued at this point because most mutagens present appeared to be direct acting. TA100 was selected for further investigations because of its high reversion rates.

The data, indicating mutagenic activity at seven treatment stages of WF21, are summarized in Table 31. During the period 4/22/80 - 7/04/80, nine sets of samples were tested. Only two of the five influent samples tested were positive during this period; one showed signs of toxicity and two were negative. At Q6 all samples tested were positive with activities ranging from 600 to 2400 NR/l. The activity at Q6 apparently resulted from addition of chlorine in the recarbonation basins at Q4. No Q8 sample (GAC effluent) was found to be positive, but mutagenicity reappeared at Q9 where all samples were positive. The only exception was the sample taken 4/22/80 where no activity was observed. Here the activities ranged from 0 to 2400 NR/l.

TABLE 29. SUMMARY OF ACTIVITY (NR/L) MEASURED IN XAD-8/ACETONE CONCENTRATES

Location	Inf. (Q1)	Chem. Eff. (Q2)	Air Eff. (Q4)	Filt. Eff. (Q6)	GAC Eff. (Q8)	Chlor. Eff. (Q9)	RO Eff. (Q22B)
TA100 without MA							
Number of Tests	15	2	2	12	8	26	12
Number of Positives	6	0	0	12	0	20	0
Average Activity	368	0	0	1455	0	873	0
Standard Deviation*	493	--	--	830	--	787	--
Range	n-1250	--	--	510-3036	--	n-2479	--
TA98 without MA							
Number of Tests	8	0	0	1	1	4	5
Number of Positives	4	--	--	1	0	3	0
Average Activity	232	--	--	659	--	233	--
Standard Deviation*	311	--	--	--	--	298	--
Range	n-888	--	--	659	--	n-655	--

n = negative, no activity above the detection limit
-- = not applicable
* = calculated by setting negative = 0

TABLE 30. MUTAGENIC ACTIVITY AT Q1, Q9 AND Q22B AGAINST TA98 AND TA100, WITHOUT AND WITH METABOLIC ACTIVATION, IN NET REVERTANTS/LITER

Sample	Location, Date	TA98		TA100	
		-MA	+MA	-MA	+MA
Influent	Q1				
	12/25/79	300	0	1200	400
	12/31/79	300	0	700	300
Recarb. effluent	Q6				
	4/22/80	700	--	1000	
GAC effluent	Q8				
	4/22/80	0		0	
Cl effluent	Q9				
	12/25/79	100	0	800	400
	12/31/79	600	0	2500	1100
	4/14/80	100	--	1200	--
	4/22/80	0		0	
RO effluent	Q22B				
	12/25/79	0	0	0	0
	12/31/79	0	0	0	0
	1/25/80	0	0	0	0

-MA = no metabolic activation
+MA = with metabolic activation
0 = no activity above detection limit
-- = not determined

TABLE 31. MUTAGENIC ACTIVITY AGAINST TA100 AT WF21 SAMPLING LOCATIONS, EXTRACTED WITH XAD-8 (ACETONE ELUATE)*

	Location						
Date	Inf. (Q1)	Chem. Eff. (Q2)	Air Eff. (Q4)	Filt. Eff. (Q6)	GAC Eff. (Q8)	Chlor. Eff. (Q9)	RO Eff. (Q22B)
4/22/80	--	--	--	1000	0	0	--
4/25/80	1000	--	--	--	--	500	--
5/01/80	1100	--	--	--	--	800	--
5/22/80	T	--	--	--	--	500	0
5/28/80	--	--	--	2400(T)	0	2400	0
6/17/80	--	--	0	600	0	1600	--
6/21/80	--	--	0	2300	0	1800	--
6/27/80	0	0	--	1100	--	--	--
7/04/80	0	0	0	--	--	600	--

*net revertants per liter
-- = not determined
T = toxicity
0 = no positive response observed

In four instances, direct quantitative comparison of Q6 and Q9 was possible. On 4/22/80 activity was observed in Q6 but not in Q8 nor in Q9. In two cases (5/28/80 and 6/21/80) the activities at Q6 and Q9 were remarkably close, whereas in the sample set taken 6/17/80 the activity appeared to be significantly higher in Q9 in spite of activated carbon adsorption in between Q6 and Q9. This suggested that precursors were not removed completely all the time and that perhaps the chlorination conditions were governing the amount of activity produced.

Results from Testing Subfractions

The XAD-8 concentrates were separated into nonpolar and polar fractions by silica gel chromatography in an attempt to further characterize the mutagenicity-causing compounds. A nonpolar fraction was eluted with $MeCl_2$, and a more polar fraction was eluted with MeOH. An unfractionated aliquot of the XAD-8 concentrate was tested along with the corresponding $MeCl_2$ and MeOH subfractions. Samples were taken from Q6, Q8 and Q9, where the impact of chlorination was most easily observed. The results are summarized in Table 32. In all cases the mutagenicity present in the unfractionated controls appeared in the MeOH fractions; the fractions eluted with $MeCl_2$ were negative. In the set taken 1/26/81, activity was not detected in the controls but was detected after fractionation at low levels. This suggested inhibition of activity by materials separated in the $MeCl_2$ fraction. The activity

TABLE 32. MUTAGENIC ACTIVITY (IN NR/L) AGAINST TA100
IN XAD-8-ACETONE CONCENTRATES AND $MeCl_2$
AND MeOH SUBFRACTIONS

Date	Location	XAD-8 Conc.*	$MeCl_2$	MeOH
8/12/80	Q6	3000	0	900
	Q9	2400	0	3100
10/10/80	Q9	1000	0	500
11/25/80	Q8	0	0	0
	Q9	0	0	0
12/9/80	Q6	3700	0	?T
	Q8	0	0	0
	Q9	400	0	1000
1/26/81	Q6	0	--	400
	Q8	0	--	200
	Q9	0	--	500

*unfractionated XAD-8 concentrate
-- = not determined
? = questionable positive response
T = toxicity

detected in the MeOH fraction of Q8 (1/26/80) was the only case where weak activity appeared to break through the activated carbon columns. The activity was weak relative to background levels, however.

Chemical Characterization of Active Fractions

Methylated MeOH fractions were subjected to GC/MS analysis for chemical characterization. Numerous peaks were detected, most of which appeared to be carboxylic acids. Manual (25,26) and computer assisted mass spectra comparisons suggested the presence of the methylesters of the following acids: dehydroabietic acid and other unidentified compounds with similar spectra, fatty acids, toluene sulfonic acid, benzoic acid, and clofibric acid. Clofibric acid, which has previously been found in wastewater, is a metabolite of the drug clofibrate (27,28). However, the largest group of constituents belonged to a complex mixture of brominated and non-brominated compounds. Based on their spectra, two main groups could be distinguished. The first group (the 207-group) which eluted between 40 and 60 minutes had spectra with a base peak of m/z 207. The second group (the 117-group) eluted between 50 and 70 minutes, and had spectra with a prominent fragment at m/z 117. Spectra for the largest peak from these groups are given elsewhere (29).

A fraction of the 117-group appeared to contain bromine as was suggested by the presence of characteristic isotope clusters. The degree of bromination appeared to vary widely from sample to sample but clearly increased at the chlorination stages. The spectra of these compounds appeared to belong to either of two subgroups, one characterized by a cluster at m/z 210-216 (the 213-group) and one by a cluster at m/z 200-206 (the 203-group) (29).

The spectra of these groups were absent in commercially available spectra compilations (25,26) but seemed very closely to match spectra of compounds detected previously in mutagenic concentrates of the Palo Alto Water Reclamation Facility (PAWRF) (29). This prompted a new effort to elucidate their structure and to reexamine previously acquired high resolution spectra from studies at the PAWRF. A 1-liter sample of chlorinated secondary effluent taken on 2/27/79 had been extracted with $MeCl_2$ (3 x 20 ml) at pH 2, the methylated extract was subjected to GC/MS and GC/HRMS, and a scan had been acquired in which some of the typical fragments were present. In Table 33 the exact masses of these fragments are given along with matching elemental compositions and relative intensities.

The HRMS data suggested that the cluster at 400/402 consisted of $C_{19}H_{29}O_4Br$. The cluster at 329/331 ($C_{14}H_{19}O_4Br$) appeared to originate from a loss of a pentyl group. Other fragments detected were m/z 117 and the cluster m/z 134/135, which were matched to $C_5H_9O_3$ and $C_9H_{10}O$ + H respectively. Fragment 59.047 was matched to C_3H_7O, fragment 43.056 to C_3H_7 and 41.038 to C_3H_5. However, the two clusters present in the low resolution spectra suspected to contain bromine, m/z 200-210 and m/z 210-216, were missing in the HRMS scan. It was therefore suspected that the HR mass spectrum was incomplete and possibly consisted of overlapping spectra of two closely eluting GC peaks. The slow scan time (8 secs) and the insufficient resolution of the packed column may have been inadequate for analysis of the complex mixture at hand.

The crux of spectrum identification was fragment m/z 117. To aid structural elucidation, an EI^+ daughter-ion experiment was conducted using GC/TSQ MS. The daughter-ion spectrum of fragment m/z 117 produced by CAD with N_2 (29) indicated that this fragment looses neutral fragments of mass 44 and 58 resulting in the fragment ions m/z 73 and 59 respectively. These losses were tentatively assigned to C_2H_4O and $C_2H_4OCH_2$, which leaves $C_2H_3O_2$ for m/z 59. This is consistent with the elemental composition of a methylated carboxyl group. By assigning the loss of 71 from the apparent molecular ions 322 and 400 to a pentyl group and by recognizing the aromatic and phenolic elements of the spectrum, structures I and II depicted in Figure 23 could be proposed. The relatively high intensity of m/z 135 was taken as an indication of the presence of two methyl groups (or an ethyl group) at the α-carbon in the aliphatic sidechain. The fragmentation patterns proposed in Figure 23 may explain the presence of the major fragments. For the group with m/z 207 as a base peak no HRMS or TSQ MS data was available and these spectra are consequently less understood. A structure of type III is suggested as a possibility. There appeared to be three reasons for the great complexity of the mixture. The presence of compounds differing in their apparent molecular weight by 14 amu indicated the presence of a series of homologues. The presence of compounds differing in their apparent molecular weight by 44 suggested the presence of compounds having side chains with different numbers of ethoxy (ETO) units. The presence of compounds with the same apparent molecular weight but with slightly different GC retention times and with similar spectra suggested the occurrence of differently branched alkyl side chains.

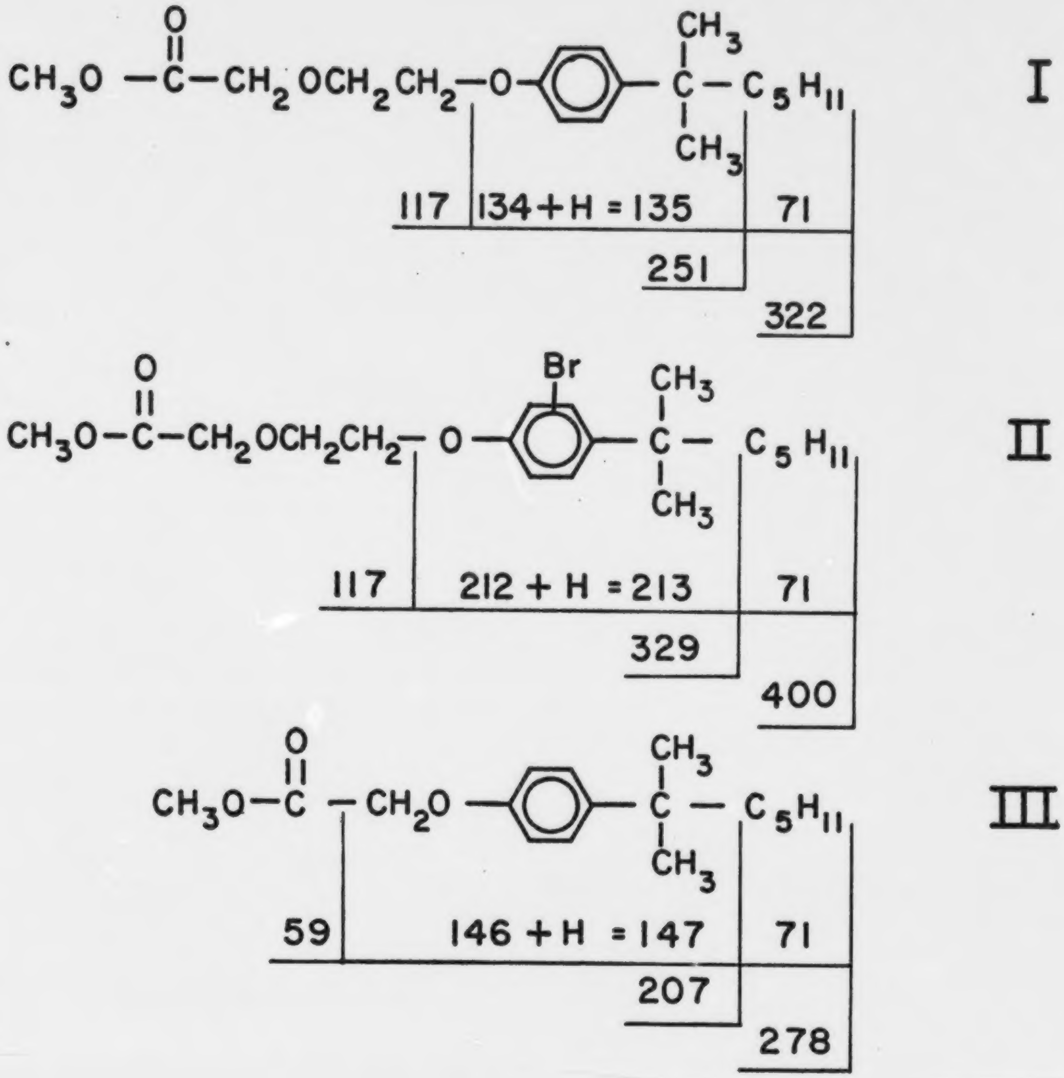

I
117
134+H = 135
71
251
322
Br
II
117
212 + H = 213
71
329
400
III
59
146 + H = 147
71
207
278

Figure 23. Proposed structures of APEC and BrAPEC compounds representative of 117-group (I), 213-group (II), and 207-group (III); fragmentation is tentative.

TABLE 33. EXACT MASSES, RELATIVE ABUNDANCE, MMU ERROR AND SUGGESTED ELEMENTAL COMPOSITION OF MAJOR FRAGMENTS OF BROMINATED COMPOUND IN MUTAGENIC EXTRACTS FROM PAWRF

Mass	% Area	MMU Error	Composition
41.0385	7.8	-0.652	C_3H_5
43.0561	5.2	1.349	C_3H_7
57.0340	1.8	-0.073	C_3H_5O
57.0705	17.1	0.087	C_3H_9
59.0471	11.8	-0.567	C_3H_7O
117.0563	100.0	1.175	$C_5H_9O_3$
134.0759	3.5	2.742	$C_9H_{10}O$
135.0802	2.9	1.034	$C_9H_{11}O$
329.0342	41.2	-8.176	$C_{14}H_{19}O_4{}^{79}BR$
331.0391	34.9	2.233	$C_{14}H_{18}O_4{}^{81}BR$
400.1243	5.8	-0.608	$C_{19}H_{29}O_4{}^{79}BR$
402.1187	6.4	-4.194	$C_{19}H_{29}O_4{}^{81}BR$

In order to study spectra of compounds similar to those proposed in Figure 23, commercially available alkylphenol polyethoxylates (APEs) were converted to the alkyphenol polyethoxy carboxylates (APECs) and brominated alkylphenol polyethoxy carboxylates (BrAPECs). The APE standard used was specified by the supplier as "polyethoxylated tert. octylphenol" with three ETO units per molecule. But GC/MS analysis indicated that a mixture of APEs was present with the number of ETO units per molecule ranging from one to greater than three. Spectra apparently belonging to the 207-group and the 117-group (30) were found in the APE mixture after oxidation. Visual comparison of the spectra suggested that the compounds produced chemically were of the same type as those present in the standard mixture. Bromination followed by oxidation of the APE mixture produced compounds with spectra similar to those found in the concentrates. Chemically produced methylated BrAPEC mixture was coinjected with an extract and it was observed that BrAPECs with apparent MW of 400 coeluted. This seemed to confirm that the mixture produced chemically contained the same or closely related compounds as the extracts. Further characterization of the composition of the complex APEC and BrAPEC mixture present in the water extracts was beyond the scope of this work.

Mutagenic Response of BrAPECs

Because of the prevalent occurrence of the APEC and BrAPEC compounds in the mutagenic fraction, an attempt was made to relate their presence to the mutagenicity data. BrAPECs were clearly products of chlorination, and it was suspected that they were the cause of the mutagenicity in the chlorinated samples.

Non-brominated isomers detected with MC 207 and 251 were present in both the GAC influent (Q6) and effluent (Q8). Their presence in Q8 indicated that they were breaking through the GAC column. However, they were not found in either of the chlorinated effluent (Q9) extracts. No BrAPECs were detected in the Q6 sample taken on 12/9/80, where the mutagenic response was questionable (the two values above twice background, exhibited toxicity and a no dose-response). However, BrAPECs of the 213 type were present in Q9 samples where a clear mutagenic response was observed. In the second set BrAPECs were present in Q6 (203- and 213-type) and Q9 (203-type), which were both positive but were absent in Q8, which was negative. This indicated that bromination of APECs occurred during chlorination and suggested that BrAPECs produced the observed mutagenic response.

To further explore the BrAPECs as potential mutagens, the mixture prepared in the laboratory was subjected to Ames testing. It did not produce a mutagenic effect, but was toxic at higher doses. In another experiment, the XAD-8/acetone extract of a 1-gal Q6 sample (sampled 5/20/81) was split into two halves A and B. A was tested as previously, B was redissolved in 10 ml 0.1 N NaOH. The next day, the organics were reextracted using the XAD-8 adsorption method. The extract was split into two portions, one for Ames testing and one for chemical characterization. Comparison of the responses to A and B revealed that treatment of B with base apparently destroyed the mutagens that gave a positive response in A. However, comparison of the MC 213 profiles in A and B did not indicate an observable difference. The 203 profile was absent in A and in B. These two experiments seemed to counter the hypothesis that the mutagenicity observed at Q6 and Q9 was due to BrAPEC compounds detected with MC 203 and 213.

Results from Procedures Other Than XAD-8 Adsorption

The tests performed with the procedures other than XAD-8 adsorption are summarized in Table 34. The neutral fractions, the hydrophilic bases and acids, the volatiles and the UF concentrates all failed to produce a mutagenic response when tested after 100-fold (UF) to 1000-fold (all others) concentration. Since a concentration factor of 1000 was sufficient to detect activity with the standard XAD-8/acetone procedure, no further efforts were made to increase the concentration factors. The most potent mutagens present in WF21 water appeared to be hydrophobic and further efforts were directed towards the characterization of the hydrophobic fractions.

An effort was made to compare mutagenicity and the chemical composition of CLLE extracts with XAD-8/acetone concentrates. A 4 liter chlorinated effluent (Q9) sample (2/26/81) was split into two halves A and B. Sample A was extracted using the XAD-8/acetone method and Sample B was extracted using the standard CLLE method. A first extraction was performed at pH 11 to remove the base/neutral (B/N) fraction. Then the pH was lowered to 2 and the acid/phenol (A/P) fraction was extracted. The solvent for the A/P fraction was changed to DMSO and the concentrate was subjected to a mutagenic analysis along with the MeOH fraction of the XAD-8 concentrate.

The data resulting from the test are given in Table 35. The CLLE concentrate did not show a mutagenic response while the MeOH fraction was positive. This suggested that the fraction, obtained by liquid-liquid extraction, did not contain the mutagens present in the MeOH fraction. There seemed to be two explanations: either the mutagens were not extracted by liquid-liquid extraction, or the base extraction destroyed the mutagens.

TABLE 34. SAMPLES TESTED WITH PROCEDURES OTHER THAN STANDARD PROCEDURE

Date	Inf. (Q1)	Filt. Eff. (Q6)	GAC Eff. (Q8)	Chlor. Eff. (Q9)	RO Eff. (Q22B)
12/25/79	N			N	N
12/31/79	N			N	N
1/25/80	N			N	N
2/4/80	N				
2/19/80	N				N
2/28/80					N
3/10/80	C,A				
3/25/80	C,A				C,A
4/2/80					C,A
4/14/80	C,A			C,A	
4/22/80	C,A	C,A	C,A	C,A	
4/25/80	B,C,A			B,C,A	
4/29/80				B	
5/1/80				B	
5/22/80	B			HB,HBC,B	B
8/12/80		C,A		C,A	
9/18/80	BM,C,A			BM,C,A	BM,C,A
1/26/81		V,UF	V,UF	V,UF	
2/16/81		V	V	V	
2/26/81		V		V,CE	
5/20/81		CE			

N = Neutral fraction
B = Eluted with 0.1 N NaOH
BM = Eluted with 30 percent MeOH in 0.1 N NaOH
C = Cation exchange concentrate
A = Anion exchange concentrate
V = Volatiles by purge and freeze trap
UF = Ultrafiltration on UM05 membrane
HB = Adsorbed on XAD-8 at pH 10; eluted with acetone
HBC = Adsorbed on XAD-8 at pH 10; eluted with 0.1 N HCl

This experiment was repeated in an extended form with a Q6 sample taken 5/20/81. It was again split in two 2-liter samples A and B. This time A was concentrated to obtain by the XAD-8/acetone method. This concentrate was split into two halves, A1 and A2. A1 was tested directly and found to be positive. A2 was dissolved in 10 ml 0.1 N NaOH. After 12 hours the solution was diluted with MQ-water to 200 ml, acidified to pH 2 and reconcentrated with the XAD-8/acetone method. This extract was found to be negative. Sample B was divided into two subsamples B1 and B2. B1 was extracted at pH 11 by CLLE followed by an extraction at pH 2. The A/P fraction was solvent exchanged to DMSO and subjected to Ames testing. The net revertants observed are given in Table 35. High values were observed at the 200 and 400 µl dose but the result did not qualify as a positive response. Subsample B2 was extracted at pH 7 and then at pH 2. Then the two extracts (A/P + N) were combined, concentrated

TABLE 35. COMPARISON OF CLLE WITH XAD-8/ACETONE (NR)

Sample	Code	Extraction Procedure	50 μg/l	100 μg/l	200 μg/l	400 μg/l	Mut. Act.	Background
Chlorinated Effl. (Q9)								
2/26/81	A	CLLE A/P	-4	34	21	38	-	149
	B	XAD MeOH	70	104	184	284	+	149
Recarb. Effl. (Q6)								
5/20/81	A1	XAD-8 MeOH	95	126	233	243	+	154
	A2	XAD-8 MeOH(b)	-12	-25	-2	-16	-	154
	B1	CLLE A/P	11	0	97	92	-	154
	B2	CLLE N+A/P	78	80	207	153	+	154

A/P = Acid/phenol fraction extracted after BN extraction at pH 11
N+A/P = Acid/phenol fraction combined with a nuetral fraction extracted at pH 7
(b) = MeOH fraction dissolved in 0.1 N NaOH and back extracted with the XAD-8/acetone method

to dryness and redissolved in 2 ml DMSO for mutagenic testing. A strong positive response was observed along with some toxicity. These observations appeared to confirm reports by others that mutagenicity produced by chlorination is labile against base. The experiment suggests that the mutagens would not have been detected in the A/P fractions prepared by CLLE analyzed within the trace organics monitoring program.

A subfraction of each of the fractions tested (25 percent) was put away for GC/MS characterization. All the samples contained BrAPECs but no significant differences could be detected between the positive and the negative extracts. This suggests that the mutagenic compounds were not among those examined.

DISCUSSION AND CONCLUSIONS

WF21 received a secondary effluent in which direct acting mutagens were detected about 50 percent of the time. The data obtained suggests that the mutagens were removed or destroyed during treatment, as indicated by the absence of mutagenicity in the GAC and RO effluents. WF21 influent also appeared to contain precursors that were converted into direct acting mutagens during chlorination. Increased activities were found at Q6 following chlorination. The mutagens formed there were removed during subsequent GAC adsorption. In the GAC effluent, only one marginal case of activity was detected. However, the precursors were not sufficiently removed by GAC adsorption, as was indicated by the eocurrence of mutagenicity during final chlorination for disinfection (Q9). By and large, activity appeared to be as strong in the final chlorinated effluent as in the chlorinated recarbonation basin effluent. None of the RO effluent samples tested exhibited a mutagenic response. Because the RO effluent was not chlorinated, it is not known whether the precursor materials were removed by RO.

The non-volatile mutagens formed during chlorination at WF21 appeared to be associated with hydrophobic acids. Analysis of the mutagenic fraction revealed the presence of a variety of organic acids within this fraction and compounds tentatively identified as APECs and BrAPECs appeared to be the major constituents.

The fact that BrAPECs appeared to be formed during chlorination suggests that these compounds were involved in producing a mutagenic response. But preliminary experiments with chemically produced BrAPECs do not support this hypothesis. Thus the coincidence of mutagenicity and BrAPECs might have been accidental. Various reasons could explain this apparent discrepancy: (i) the chemically produced mixture did not reflect the mixture found in the mutagenic fractions, (ii) the difference in halogenation conditions might have led to different products (for instance small amounts of side chain brominated products might have been formed under plant chlorination conditions), or (iii) the active compounds were not detected with the analytical procedure used. Clearly, an evaluation of these questions is complex and requires much more study.

APEs, from which APECs and BrAPECs are suspected to be derived, were also detected in the B/N fraction and reported previously to occur in wastewater effluents (31,32). Little is known about their health and environmental significance, and only limited data are available on their occurrence and fate in the environment (33). APEs are presently in use as industrial and domestic surfactants. The current amount of APEs produced is not known but in 1962, about 50,000 tons were used in laundry detergent formulations (34). APEs are reported to be removed during activated sludge treatment and trickling filter sewage treatment (37) but it is known that APE residues are rather recalcitrant, particularly when the hydrophobic alkylgroups are highly branched (34). Long-chain APEs (10 ETO) were shown to undergo biological degradation to short-chain APEs (1-2 ETO) which were highly resistant to further degradation (35). It also seems likely that bromination (and chlorination if it should occur) will render these molecules even more refractory and more lipophilic. Both of those characteristics are likely to cause greater persistence in the environment and possibly accumulation in the food chain. It seems necessary to address these questions as well as the public health significance of these residues in more detailed studies.

The fact that brominated but not chlorinated species were detected is interesting. It suggests the presence of highly reactive brominating agents in the chlorinated water, possibly bromine (Br_2), bromine chloride (BrCl) or bromochloromonoxide (BrOCl). Most studies of chlorination effects in the past have been directed towards chlorinated by-products. The fact that all brominated haloforms are mutagenic (36) and that aromatics appear to be preferentially brominated during wastewater chlorination suggests that bromine incorporation into organic materials should receive more attention. Bromide ion in the water being converted to hypobromous acid (HOBr) is also a likely source of brominating agents produced during chlorination.

SECTION 10

ASSAYS FOR VIRUSES AND PARASITES

INTRODUCTION

Another area of public health concern, when considering the potable reuse of reclaimed water, is control of viruses and other pathogens that are found in municipal wastewaters. Like the current testing procedures used for evaluating the potential health effects of mixtures of organic chemicals discussed in Section 9, virus monitoring systems capable of detecting all known viruses do not exist. At the present, a monitoring system has not been developed for some viruses which cause serious illness. Examples of these are the hepatitis virus, rotaviruses, and Norwalk-type agent (presumed to be parvoviruses), all of which cannot be easily grown in the laboratory cell cultures, but which can be detected in the feces of infected humans by electron microscopic techniques.

Since 1971, a more focused effort between the United States Environmental Protection Agency and the Center for Disease Control has been in effect to investigate, document, and report waterborne-disease outbreaks in the United States. The etiologic agent was determined in only 43% of the 192 outbreaks. The most commonly identified pathogen was Giardia lamblia, a flagellated protozoan. As a result of this observation, parasite monitoring has received more attention from public health officials (37).

Another objective of this study was to monitor for viruses and parasites in the influent water treated by WF21, and to determine the effectiveness of the advanced wastewater treatment processes in their removal. This section provides detailed results of virus and parasite monitoring for the operating period of October 1980 to October 1981. It also provides a summary of additional virus data which has been collected during the last five years of operation.

VIRUS METHODS

Virus Sampling

Large volume grab samples were collected from various sampling stations through the WF21 treatment process. The actual sample volume for virus concentration was determined from previously described breakthrough experiments conducted at each station (38). Table 36 summarizes the sample volumes used at the stations for both virus and parasites.

TABLE 36. VIRUS SAMPLING STATIONS AND VOLUMES CONCENTRATED

Sampling Station Code	Description	Sample Volume for Viruses, liters	Sample Volume for Parasites, liters
Q1	WF21 Influent	75-200	300-500
Q2	Lime Treated Effluent	950	--
Q6	Filtered Effluent	950	--
Q8	GAC Effluent	950	--
Q9	Chlorinated Effluent	1900	1900*
Q22B	Reverse Osmosis Effluent	1900	1900

*One sample was 950 liters.

Virus Concentration

The method employed was similar in principle to Method 973A, the filter adsorption elution procedure described in the 15th Edition of Standard Methods (7). The sample was first adjusted to pH 3.5 with HCl, and then plant alum was added to obtain a final concentration of 0.005 M Al(III). The water was then pumped through a 25 cm 0.45 μm fiberglass-melamine impregnated, paper-epoxy, pleated Filterite filter at 5 gallons per minute (0.3 l/s) to adsorb the viruses. The viruses then were eluted from the filter in a co-current manner with one liter of 3% beef extract (Difco) at pH 9.0. The eluant was collected and readjusted to pH 9.0 with 1 N NaOH. Then the filter was re-eluted in a counter-current manner, thereby backwashing the solids-associated viruses. The eluant was adjusted to pH 7.0 with 1 N HCl and stored at 4°C until transported to the James M. Montgomery, Consulting Engineers, Inc. - Environmental Research Laboratory (JMM-ERL) in Pasadena.

In Pasadena, the eluant was further reduced in volume by an organic flocculation technique (39). The eluant was adjusted to pH 3.5, which is near the isoelectric point of many enteroviruses and proteins, causing them to coagulate and flocculate. The pH was held at 3.5 for 30 minutes, then the eluant was centrifuged at 3200 rpm to pelletize the proteins, solids, and viruses. The pellet was next resuspended in approximately 30 ml of 0.15 M sodium phosphate buffer, pH 9.0. The resulting solution was treated with antibiotics and incubated at 37°C for one and one-half hours, then frozen at -70°C until assayed.

Virus Assay

After an initial screening procedure for toxicity, samples were inoculated into BGM and RD liquid cell cultures using 0.5 ml per 25 cm^2 of cells. The cell monolayer was maintained with a liquid medium and microscopically observed for gradual and progressive destruction of the cells by virus infection (cytopathic effect, CPE). The cultures were observed and scored from days 2 through 15 post-inoculation. These samples were then filtered through a 0.22 µm filter, and 0.2 ml of the filtrate was inoculated into a fresh tube culture containing cells of a similar type. This confirmation procedure utilized dilution and filtration as quality control steps to eliminate toxicity and other microbial agents which may cause non-viral isolation cultures. At the end of this incubation period, the tubes were passed for the second time and incubated in a similar fashion. Positive tubes from this final confirmation passage were used to calculate the most probable number cytopathic unit (MPNCU)/ml of concentrate using the formula (40):

$$\text{MPNCU} = -\ln(S/N)/V$$

where,

MPNCU = most probable number of cytopathic units/ml of concentrate
V = ml of concentrate inoculated per tube
S = number of negative tubes
N = number of tubes inoculated

The resultant number was then calculated based on the volume concentrated to determine the MPNCU/liter.

Virus Identification

The Lim Benyesh-Melnick cross section antisera (38) were used to identify the virus isolates. A microtiter system with CPE as a response was used to make some identifications, while the majority of the identifications were made using a plaque reduction technique. Details of the identified viruses, recovery efficiencies by methods used, and quality control are provided in separate reports (2, 38, 53) and so are not repeated here.

PARASITE METHODS

Parasite Sampling

The JMM-ERL utilized a modified version of EPA's 1978 method for detecting Giardia and other parasites in water (41). The collection device consisted of a 5.0 µm effective size, 25 cm orlon wound, polypropylene core depth filter (Carborundum Company).

Generally sample volumes ranged from 380-1900 liters dependent upon the water quality. Actual sample volumes are shown in Table 36. Flow rates of 11 liters per minute at line pressures of 15-70 psi were maintained during sample collection. After sampling, the filters were placed in polypropylene zip-lock bags and shipped on wet ice to JMM-ERL. A 10% Formalin fixative solution was added to the zip-lock bag containing the filter upon receipt at JMM-ERL.

Sample Reconcentration

The filter was aseptically removed from the zip-lock bag and placed into an enamelware tray. A razor blade was used to cut an end strand from the filter, and the filter was unwound from the cores. The resulting filter mat was divided into quarters. Each quarter portion was placed into a polypropylene bag, approximately 25 x 25 cm, with 250 ml of distilled water. The bag was kneaded until the fibers appeared white, the original color. A corner was snipped from the bottom of the bag to drain the water containing the parasites into a 1-liter sterile centrifuge bottle. The contents of the bag were squeezed to remove as much water as possible. The water was allowed to settle three to four hours, then centrifuged for three minutes at 450 times gravity (g). The resulting sample pellet was washed three times by resuspending a final time and centrifuged for five minutes at 450 g. The supernatant was aspirated until approximately 50 ml remained. This material was transferred to a 50 ml conical tube and centrifuged for three to five minutes at 350 g. As much supernatant as possible was removed without disturbing the pellet.

Flotation

To concentrate the sample material, JMM-ERL utilized the zinc sulfate ($ZnSO_4$) flotation technique (42), which is designed to separate the parasite components from inorganic debris through differences in specific gravity. The $ZnSO_4$ solution has a specific gravity of 1.18-1.2. Protozoan cysts and certain helminth eggs floated to the top and were recovered in the surface film, while the inorganic debris pelleted at the bottom of the tube after centrifugation. If less than 1 ml of sediment was obtained during the processing, the pellet was vortexed with 5-10 ml of $ZnSO_4$.

This suspension was transferred to a 15 ml conical tube. The tube was slowly filled to the brim with $ZnSO_4$ with care not to spill the sample. The tube was then centrifuged with a swing bracket rotor for five minutes at 300 g without braking. The tube was gently removed from the centrifuge without any agitation or vibration.

Staining

A drop of either Lugol's or D'Antonio's Iodine stain was placed on a clean, grease-free microscope slide. After flaming and cooling, a wire loop, diameter of 5 to 7 mm, was used to remove 1 to 2 drops from the center of the tube's surface film and to place it on the prepared slide. A clean No. 1 coverslip (22 x 22 mm) was placed upon the stained material.

Parasite Identification

The stained slide was examined microscopically under 10x, 20x, 40x, and oil immersion (1000x). The U.S. EPA has established criteria guidelines in order to report positive identifications (43). In most cases the size and observation of one or more characteristic morphological features (i.e., nuclei, organelles, terminal knobs) are required for positive identification. These criteria were used for verifying all samples examined during the course of this study.

RESULTS

Enteric Viruses

WF21 Influent, Q1 --

A considerable amount of information on viruses in WF21 influent (Q1) has been collected in this study and in previous monitoring programs (38). Prior to 1978, the secondary effluent entering WF21 was treated by trickling filters; since that time, the activated sludge process was used. With the change, viruses at Q1 have decreased substantially.

The Q1 data collected for this study from March 1980 to April 1981 is summarized in Table 37. A total of 35 samples, analyzed on BGM and RD cell lines, were taken at Q1. Thirteen of the BGM tests and 14 of the RD tests were positive for enteric viruses at Q1; on other occasions, no viruses were detected. For a historical perspective the results from early periods spanning February 1979 through December 1979 are summarized in Table 38.

Graphical representation of all the Q1 activated sludge data obtained (May 1978-April 1981) showing the frequency distribution is presented in Figure 24 for the BGM and RD cell lines. The statistics associated with these two lines are summarized in Table 39. The geometric means are 0.025 and 0.015 MPNCU/liter for the BGM and RD cell lines, respectively, when activated sludge effluent was the influent to WF21. These means and slopes are not signifcantly different at the 95% confidence interval using the Student's "t" test. Statistics for a previous period (October 1976 through January 1978) when trickling filter effluent was used by WF21 are also summarized in Table 39. Overall, the activated sludge effluent mean was 1.5 logs (orders of magnitude) lower than the trickling filter effluent.

Raw sewage levels typically range from a few PFU/liter to 12,000 PFU/liter (44,45). Based on removal efficiencies of 90% for the activated sludge process, this would result in none detected to 1200 PFU/liter in secondary effluent (45). The mean values found at WF21 are within this range, which is not surprising. In a limited number of Q1 samples assayed by Los Angeles County Sanitation Districts (LACSD) the geometric mean was 0.1 MPNCU/liter on the BGM cell line (46). This would indicate that the results reported in this study are representative of the virus detection method.

Several authors have reviewed the enteric virus literature and have summarized the removal efficiency for the activated sludge process to be 90%. Preliminary data from LACSD indicates that the activated sludge processes remove as much as 4 logs (99.99%) of enteric viruses. Literature surveys by Sproul (47) and Feachem et. al (44) suggest that the trickling filter process can remove an average of 50% of the enteric viruses (44,45,47). The observed difference between the activated sludge and the trickling filter process at Q1 was 1.5 logs (95%). This would be larger than the expected removal based on the literature surveys, but less than that observed by the LACSD. Removals can be expected to be operationally dependent and site specific; therefore, it would appear that these results are reasonable.

TABLE 37. SUMMARY OF VIRUS RESULTS SAMPLES COLLECTED MARCH 1980-APRIL 1981

Date of Sample	Inf-Q1 BGM	Inf-Q1 RD	Chem Eff-Q2 BGM	Chem Eff-Q2 RD	GAC Inf-Q6 BGM	GAC Inf-Q6 RD	GAC Eff-Q8 BGM	GAC Eff-Q8 RD	Chlor Eff-Q9 BGM	Chlor Eff-Q9 RD	RO Eff-Q22B BGM	RO Eff-Q22B RD
	Virus Concentration (MPNCU/liter)											
3/6/80	0.11	0.07	--	--	--	--	--	--	--	--	ND	ND
3/14/80	0.66	0.44	--	--	--	--	--	--	--	--	ND	ND
3/20/80	ND	ND	--	--	--	--	--	--	--	--	ND	ND
4/4/80	ND	ND	--	--	--	--	--	--	--	--	ND	ND
4/8/80	ND	ND	--	--	--	--	--	--	--	--	ND	ND
4/16/80	ND	ND	--	--	--	--	--	--	ND	ND	--	--
4/23/80	ND	0.10	--	--	--	--	--	--	ND	ND	--	--
5/1/80	ND	ND	--	--	--	--	--	--	ND	ND	--	--
5/21/80	ND	0.06	--	--	--	--	--	--	ND	ND	--	--
5/29/80	0.05	0.26	--	--	--	--	--	--	ND	ND	--	--
6/3/80	ND	ND	--	--	--	--	--	--	ND	ND	--	--
6/19/80	0.10	0.03	--	--	--	--	--	--	ND	ND	--	--
6/24/80	ND	ND	--	--	--	--	--	--	ND	ND	--	--
7/9/80	ND	ND	--	--	--	--	--	--	ND	ND	ND	ND
7/17/80	0.10	0.03	--	--	--	--	--	--	--	--	ND	ND
7/23/80	ND	ND	--	--	--	--	--	--	ND	ND	ND	ND
8/26/80	0.97	0.58	--	--	--	--	--	--	ND	ND	ND	ND
9/4/80	0.97	0.61	--	--	--	--	--	--	ND	ND	0.04	ND
9/11/80	ND	ND	--	--	--	--	--	--	ND	ND	ND	ND
10/14/80	0.08	ND	ND	ND	ND	ND	--	--	--	--	--	--
10/15/80	ND	ND	ND	ND	ND	ND	--	--	ND	ND	--	--
10/16/80	ND	0.22	ND	ND	ND	ND	--	--	--	--	--	--
10/17/80	1.3	1.3	ND	ND	ND	ND	--	--	--	--	--	--
10/22/80	--	--	ND	ND	--	--	ND	ND	--	--	--	--
10/23/80	--	--	ND	ND	--	--	ND	ND	--	--	--	--
10/28/80	--	--	ND	ND	--	--	ND	ND	--	--	--	--
10/30/80	ND	ND	ND	ND	--	--	ND	ND	--	--	--	--
10/31/80	ND	ND	--	--	--	--	--	--	ND	ND	--	--
11/6/80	ND	ND	--	--	--	--	ND	ND	--	--	--	--
11/7/80	0.06	ND	--	--	--	--	--	--	ND	ND	ND	ND
11/11/80	0.02	ND	--	--	--	--	--	--	--	--	--	--
11/12/80	ND	0.02	--	--	--	--	--	--	--	--	--	--
11/26/80	--	--	--	--	--	--	--	--	ND	ND	ND	ND
11/27/80	ND	ND	--	--	--	--	--	--	--	--	--	--
12/4/80	ND	ND	--	--	--	--	--	--	ND	ND	ND	ND
2/25/81	0.06	0.06	--	--	--	--	--	--	ND	ND	ND	ND
3/12/81	0.06	0.06	--	--	--	--	--	--	ND	ND	ND	ND
3/19/81	ND	ND	--	--	--	--	--	--	ND	ND	ND	ND
4/9/81	--	--	--	--	--	--	--	--	--	--	ND	ND
4/23/81	ND	ND	--	--	--	--	--	--	--	--	ND	ND

ND = Not Detected
-- = Not Sampled

TABLE 38. SUMMARY OF VIRUS RESULTS
SAMPLES COLLECTED FEBRUARY 1979-DECEMBER 1979

Date of Sample	Virus Concentration (MPNCU/liter) Influent (Q1) BGM	RD	Chlor Effluent (Q9) BGM	RD
2/22/79	0.07	0.24	ND	ND
2/27/79	ND	0.20	ND	ND
3/2/79	0.06	0.04	ND	ND
3/7/79	ND	ND	ND	ND
3/13/79	0.37	0.23	ND	ND
3/16/79	ND	ND	ND	ND
3/20/79	0.05	ND	ND	ND
3/23/79	ND	ND	ND	ND
3/26/79	0.02	0.02	ND	ND
3/29/79	0.05	0.29	0.04	0.06
4/2/79	ND	ND	ND	ND
4/4/79	ND	ND	ND	ND
8/20/79	ND	ND	ND	ND
8/22/79	ND	ND	ND	ND
8/29/79	ND	ND	ND	ND
8/31/79	ND	ND	ND	ND
9/5/79	ND	ND	ND	ND
9/10/79	ND	ND	ND	ND
9/12/79	ND	ND	ND	ND
9/14/79	ND	ND	ND	ND
9/18/79	ND	ND	ND	ND
9/26/79	0.09	ND	ND	ND
10/12/79	ND	ND	ND	ND
10/16/79	ND	ND	ND	ND
10/18/79	ND	ND	ND	ND
10/23/79	ND	ND	ND	ND
11/5/79	ND	ND	ND	ND
11/8/79	0.05	0.14	ND	ND
11/13/79	ND	0.01	ND	ND
11/19/79	0.03	0.05	ND	ND
11/29/79	0.03	0.05	ND	ND
12/5/79	0.08	0.11	ND	ND
12/12/79	ND	ND	--	--

ND = Not Detected
-- = Not Sampled

Based on the data shown in Table 37, the percentages of Q1 samples positive for enteric viruses during the 1980-81 study period were 37% and 40% for the BGM and RD cell lines, respectively. This is not significantly different from results found in the earlier study period (Table 38) when both BGM and RD cell lines had 33% positive. This is in contrast to the period right after WF21 began receiving activated sludge effluent, March 1978 to February 1979, when the percent positives were 82% and 61% for BGM and RD cell lines,

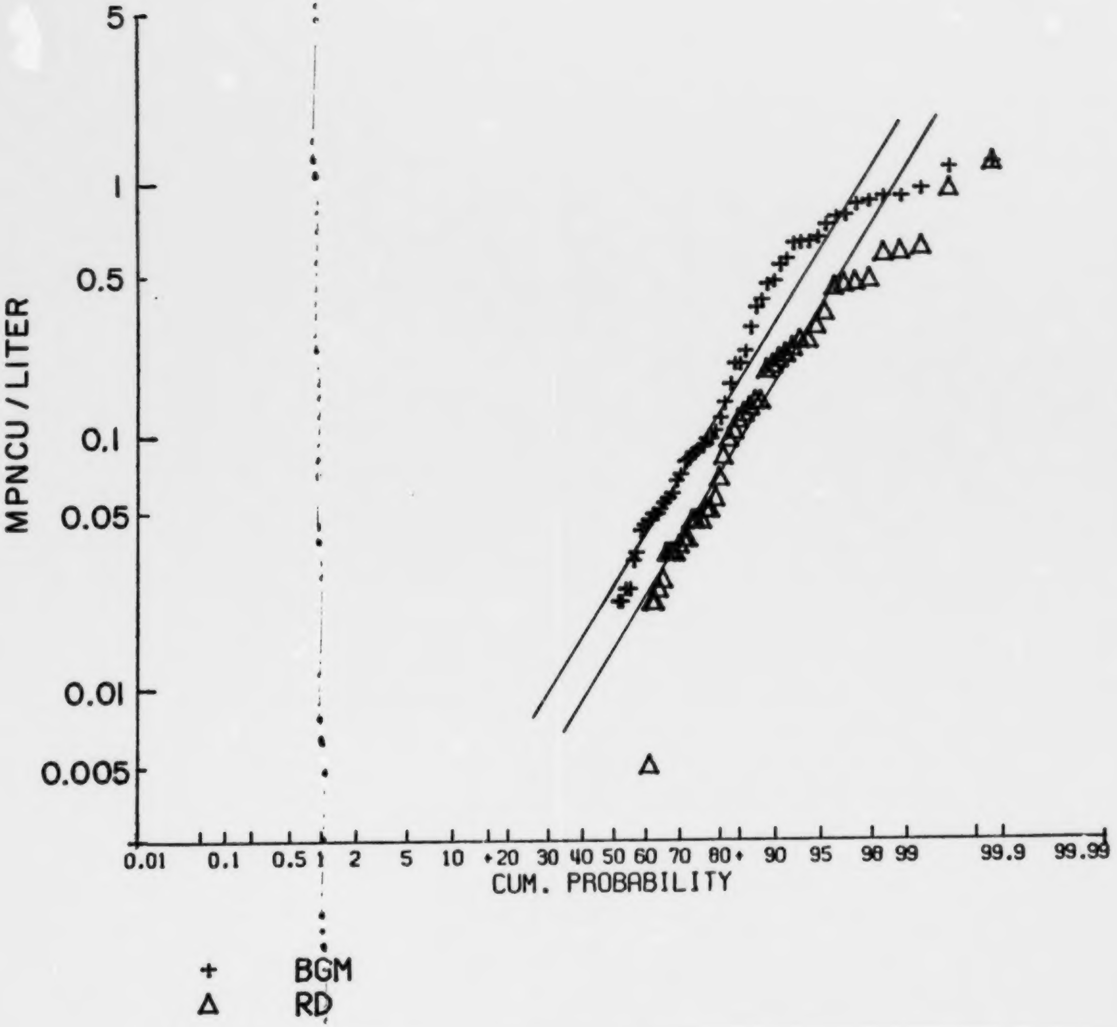


Figure 24. Comparison of BGM & RD distribution at Q1, activated sludge.

TABLE 39. VIRUS SUMMARY STATISTICS FOR WF21 INFLUENT

Distribution	Years	Mean (MPNCU/liter)	Correlation Coefficient	Slope
BGM Activated Sludge	1978-81	0.025	0.99	0.90
RD Activated Sludge	1978-81	0.015	0.96	0.92
BGM Trickling Filter	1976-78	1.3	0.98	0.65

respectively. Overall, for the period March 1978 to April 1981 when WF21 received activated sludge effluent, the percent positives at Q1 were 50% and 47%, for the BGM and the RD cell lines, respectively.

During the period from October 1976 to January 1978, when WF21 was receiving trickling filter effluent, the percent positive samples at Q1 was 73% for the BGM cell line and 66% for the RhMK cell line. Analysis of the percentage of positive samples on BGM for the trickling filter (73%) and activated sludge (50%) when all the data were combined confirmed that these percentages are significantly different.

The findings at WF21 can be compared to other virus monitoring studies. Seventy-nine percent of the raw sewage samples taken in Ottawa, Canada were positive for viruses (48). Of these positive samples reoviruses were identified in 78%, while 28% were positive for enteroviruses. The virus detection system used at WF21 is designed for enteroviruses, so it is reasonable that positives are lower there. In East Lansing, Michigan, raw sewage samples were positive 33% of the time while activated sludge effluent was positive for viruses 10% of the time (44). In Copenhagen, Denmark, 29% of the activated sludge samples were positive (49). Based on the literature it would appear that the percent positives in activated sludge effuent found at WF21 were in the same range.

The reason for the observed change in isolation frequency between March 1978-February 1979 and February 1979-81 may be attributed to two hypotheses. The first involves the treatment process. In any new expansion of a facility, an acclimation period is required to make all the required adjustments to optimize the plant. During this stage, solids and virus removal may not be as efficient, so later a higher virus removal may occur. Alternatively, assuming all things were equal, the observed change may reflect a change of the virus levels in the population. It has been well documented that several socioeconomic factors influence the virus levels in a community. One important factor is the extent of vaccination and general well-being in the population contributing sewage.

Because the virus concentrations for the activated sludge effluent samples were relatively low, the dramatic seasonal peaks (48 PFU/liter, October 1976 and 36, 37 and 45 PFU/liter October 1977) previously seen in trickling filter data were not present in 1980-81. High values in the activated sludge effluent predominantly occurred in the fall (March, August, September, and October 1980). This peaking phenomenon was not observed in the activated sludge samples for the other study periods covering 1978 and 1979.

Lime Treated Effluent, Q2; Filtered Effluent, Q6; Activated Carbon Effluent, Q8; and Chlorinated Effluent, Q9 --

A series of tests were conducted in October-November 1980 to determine the fate of viruses through other unit processes at WF21. As shown in Table 37 samples were concentrated and assayed at Q2, Q6, Q8, and Q9. No viruses were observed at these four unit process sampling stations. These results are not surprising in light of the relatively low concentration of viruses entering WF21.

Reverse Osmosis Effluent Q22B --

As shown in Table 37, the reverse osmosis effluent (Q22B) was sampled on 19 occasions during this study. For all but one sample, no viruses were detected.

Enteric viruses were isolated on September 4, 1980 from the reverse osmosis (RO) effluent. The virus were found only in the BGM cell line and were identified as Poliovirus type 1. The attempts to determine whether the virus was of vaccine strain were not successful.

RO operational data at the time of the positive virus isolate showed the sodium and sulfate rejection was normal. Of interest was the relatively high influent virus concentration (1.0 MPNCU/liter) during the period the RO effluent was positive. These values were in the upper 5% of the entire study period for the activated sludge effluent, May 1978 to April 1981, making it more likely that a passage of virus through the RO membrane would be detected.

Parasite Monitoring

WF21 Influent, Q1 --

The results of the parasite samples collected at sampling station Q1 (plant influent) are presented in Table 40. During April 1980 to April 1981, JMM-ERL analyzed ten samples of plant influent taken at sampling station Q1. During this period four samples tested positive for *Giardia*.

Giardia cysts were detected in the May through August, 1980 samples. In May and July, two *Giardia* cysts were observed from 380 and 400 liter sample volumes, respectively. Single *Giardia* cysts were detected in the June 30, 1980 and August 28, 1980 samples when sample volumes were 300 and 500 liters, respectively. No parasites were found in six of the ten samples tested.

TABLE 40. RESULTS OF PARASITE MONITORING AT WF21

Date	Q1 Giardia Cysts/380 liters	Q9 Parasites/1900 liters	Q22B Parasites/1900 liters
4/20/80	ND	ND	ND
5/19/80	2.0	ND	ND
6/30/80	1.25	ND	ND
7/30/80	1.82	ND	ND
8/28/80	0.71	ND	ND
10/15/80	ND	ND	ND
11/6/80	ND	ND	ND
12/8/80	ND	ND	ND
2/25/81	ND	ND	ND
4/12/81	ND	ND	ND

Chlorinated Effluent, Q9 --

During the period covered by this report, ten samples of chlorinated effluent were taken at sampling station Q9. No parasites were detected in any of the samples.

RO Effluent, Q22B --

Ten samples of RO effluent taken at sampling station Q22B were analyzed during the project. No parasites were detected in any of the samples.

DISCUSSION AND CONCLUSIONS

Virus Removal Unit Process

Based on previous reported data for WF21 unit process removals and on literature surveys, estimated enteric virus removals are summarized in Table 41 using the geometric mean of 0.034 MPNCU/liter and a plant flow of 57,000 m^3/d. The daily loading of WF21 is calculated to be 1.95 x 10^6 MPNCU/day.

The data presented in Table 41 indicate that a very low virus level (approximately 2 viruses per day in 57,000 m^3) may pass through the last treatment barriers which have been studied, the RO and chlorination processes. Therefore, it should not be very surprising that viruses were very infrequently isolated from both Q9 and Q22B. It should be remembered that there is the blending reservoir where an additional 12 mg/l of chlorine is added prior to injection. The injected water would, therefore, be expected to be even lower in virus concentrations. Also it is expected that once in the ground some additional dilution and removal would occur (50).

TABLE 41. ESTIMATED VIRUS REMOVALS AT WF21

Process	Estimated Removal	Total Virus in 57,000 m^3
Activated Sludge, Q1	--	1.95×10^6
Lime Treatment, Q2	99.9%	1.95×10^3
Filtration, Q6	90%	1.95×10^2
Activated Carbon, Q8	10%	1.76×10^2
Reverse Osmosis, Q22B	99%	1.76
Chlorination, Q9	99%	1.76

There has been limited research on the RO process with respect to virus removal. In a study with cellulose acetate membranes, random virus penetration was observed without any associated decrease in salt rejection capability. Sorber et al. (51), hypothesized that viruses in the feed water randomly penetrated imperfections in the membranes.

Parasite Removal by Unit Processes

Historically, water purification processes have not been developed on the basis of removing parasitic organisms, but rather on bacteria. Most outbreaks occurred as the result of consuming untreated surface water or surface water with disinfection as the only treatment. *Giardia* cysts are not reportedly destroyed by chlorination at conventional doses and contact times. It has been reported that cysts will survive concentrations of 0.5 mg/l free chlorine for 30 minutes. When outbreaks of *Giardia lamblia* have been traced to municipal water, the system has relied on disinfection, rather than flocculation and filtration. Because the protozoan cysts are resistant to the usual residual chlorine concentrations maintained in the distribution system, filtration appears to be the most important treatment barrier.

Several barriers to cysts exist at WF21, and there appears to be a low number of parasites entering the plant. There are two filtration steps at WF21 (multimedia filtration and carbon filtration) prior to final treatment (chlorination or reverse osmosis). Therefore, it is not surprising that no *Giardia* cysts were detected. The nominal size of the membrane opening in the RO process would make it close to an absolute filter for the parasites except in cases where major malfunctions through or around the membranes occurred.

SECTION 11

PLANT RELIABILITY AND AVAILABILITY

INTRODUCTION

The concept of plant reliability was discussed in previous reports on operation of WF21 (2,4,6). Reliability is a measure of how a plant actually performs in comparison with how it is supposed to perform. WF21 was designed and is being operated to furnish reclaimed water for injection into a fresh water aquifer to serve as a barrier to sea water intrusion. As such, standards for the quality of injected water have been set by the State Department of Health and the Regional Water Quality Control Board in California. These requirements are given for water resulting from blending of the chlorinated effluent (Q9), reverse osmosis effluent (Q22B), and water from a deep well. The quality of this blended water (Q10) was not the major concern of this particular study but analyses were conducted on the blended water so that the reliability in meeting these local standards could be evaluated. However, the major interest of this particular study was in the suitability of reclaimed water for use as a municipal water supply.

Presently, there are no standards available for judging the acceptability of reclaimed water for potable purposes. The extensive toxicological data generally considered necessary to judge the suitability of reclaimed water for this purpose are not yet available. However, it is generally agreed that if reclaimed water were to be a suitable source for municipal supplies, it must at least meet established drinking water standards. If it does not meet these standards, then it would not be judged suitable, regardless of the outcome of toxicological testing. In addition, health criteria have been developed for the range of priority pollutants evaluated in the study (52). These might be used as additional guidelines to evaluate the safety of reclaimed water. One of the primary purposes of this section then is to compare the reliability of WF21 in producing a water that meets current EPA drinking water standards and priority pollutant health criteria. It must be realized that this may be a necessary, but not sufficient, requirement of reclaimed water if it is to be seriously considered as a potable water supply source. In addition to reliability, another concern is availability. This represents the fraction of total time that the plant is actually in operation and available for producing water. This is discussed as the last item in this section.

STATE OF CALIFORNIA INJECTION STANDARDS

Table 42 contains a listing of the California state and regional standards for quality of injection water at WF21. The injection water is prepared in a 3785 m^3 blending tank where final chlorinated effluent (Q9), RO effluent

(Q22B), and water from deep wells is blended. During this study, deep well water comprised 35 to 50% of the blended injection water. Because the quality of the deep well water is not routinely monitored, it is not possible to make a mass balance on the constituents to determine whether any quality changes occur in the blending reservoir. However, it is not anticipated that such changes are likely to be significant.

The data indicate that the geometric mean concentration of all constituents except phenol met the state specified maximum contaminant levels (MCL). The phenol MCL is a product of the former 1962 U.S. Public Health Standards for which the concern was production of taste producing substances upon chlorination. In recognititon of the analytical difficulty of measuring phenol at the 0.001 mg/l level because of interferences, and the general coverage of this problem through the general taste and odor standards, the federal government has dropped the phenol standard. In conformance with this change, the California requirements for phenol in the injection water have also been dropped.

The percentage of time that the injection water exceeded each MCL is also listed in Table 42. The percentage exceeded values were determined in two ways. If sufficient data were available to generate a frequency distribution for the contaminant so that a geometric mean (M) and a spread factor (S) could be determined, then the percentage exceeded value was calculated through use of a table listing the cumulative frequency function for a standardized lognormal distribution as discussed previously (2, 4). This resulted in the predicted values listed in the table. Also, the percentage of time that the concentration exceeded the MCL was obtained from the results of the individual analyses. Here, the number of values exceeding the MCL was divided by the total number of analyses, and the result was multiplied by 100. These two procedures produced similar, but not exactly the same results.

Most constituents met the MCL values greater than 90 percent of the time. The measured rather than the predicted values are used by the regulatory authorities. On this basis, sodium and phenol were the only constituents that exceeded the MCL values more than 10 percent of the time.

NATIONAL INTERIM PRIMARY DRINKING WATER REGULATIONS

Table 43 contains a listing of the current primary drinking water MCL values. The contaminants listed are federally regulated to protect the health of the consumer. The table also contains the geometric mean concentration for each contaminant in the influent water to WF21 (Q1), the chlorinated effluent after GAC treatment (Q9), and the effluent after RO treatment (Q22B). The Q9 and Q22B effluents can be considered as candidates for a potable water supply. Also listed in this table is the percentage of time that the reclaimed water did not meet each specified MCL. The percentage exceeded values here were determined in either one of two ways. If sufficient data were available to generate a frequency distribution for the contaminant so that a geometric mean (M) and a spread factor (S) could be determined, then the percentage exceeded value was calculated through use of a table listing the cumulative frequency function for a standardized lognormal distribution as

TABLE 42. COMPARISON BETWEEN STATE AND REGIONAL SPECIFIED MCL FOR INJECTION WATER AND ACTUAL MEASURED CONCENTRATIONS DURING PERIOD MARCH 1978 THROUGH MARCH 1981.

		Injection Water (Q10)		
Contaminant	State Specified MCL	Geometric Mean Conc.	Predicted Percent Time MCL Exceeded*	Measured Percent Time MCL Exceeded** (No. of samples analyzed)
Elec Cond.	900 S/cm	504 S/cm	11	1 (875)
Sodium	110 mg/l	72 mg/l	16	12 (155)
Hardness ($CaCO_3$)	220 mg/l	54 mg/l	4	0 (154)
Sulfate	125 mg/l	42 mg/l	12	4 (257)
Chloride	120 mg/l	62 mg/l	8	5 (261)
Ammonium	4 mg/l	0.27 mg/l	6	3 (513)
Total Nitrogen	10 mg/l	2.8 mg/l		8 (148)
Fluoride	0.8 mg/l	0.46 mg/l	7	2 (153)
Boron	0.5 mg/l	0.4 mg/l	20	2 (155)
Chromium	0.05 mg/l	0.002 mg/l	5	4 (118)
Cadmium	0.01 mg/l	0.0007 mg/l	6	3 (140)
Selenium	0.01 mg/l	< 0.005 mg/l	—	0 (127)
Copper	1.0 mg/l	0.009 mg/l	< 0.01	0 (117)
Lead	0.05 mg/l	0.0009 mg/l	0.2	0 (118)
Mercury	0.005 mg/l	0.0005 mg/l	3	0 (107)
Arsenic	0.05 mg/l	0.004 mg/l	< 0.01	0 (105)
Iron	0.3 mg/l	0.02 mg/l	0.01	1 (138)
Manganese	0.05 mg/l	0.002 mg/l	0.1	1 (139)
Barium	1.0 mg/l	0.005 mg/l	< 0.01	0 (117)
Silver	0.05 mg/l	0.00045 mg/l	0.01	0 (118)
COD#	30 mg/l	11 mg/l	1	0.2 (459)
MBAS	0.5 mg/l	0.02 mg/l	0.8	0 (147)
Cyanide	0.2 mg/l	0.004 mg/l	0.1	0 (143)
Phenol	0.001 mg/l	0.0013 mg/l	62	60 (103)
Coliforms	2.2/100 ml	0.01/100 ml	5	3 (509)
Turbidity#	1.0 TU	0.11 TU	< 0.01	1 (408)

# MCL for COD at Q8 and for turbidity at Q6

*Based on lognormal model distribution

**Given as 100 m/n where m = no. of times MCL was exceeded out of n samples analyzed.

discussed previously (2,4). However, if most of the data were below the detection limit for a given contaminant, then mean and spread factors could not be determined. In this case the percentage exceeded value was obtained from the data directly, using the percentage of sample values that exceeded the MCL.

TABLE 43. COMPARISON OF RECLAIMED WATER QUALITY WITH EPA INTERIM PRIMARY DRINKING WATER MCL's
January 1980 to April 1981

		Inf. (Q1)		Chlor Eff. (Q9)		RO Eff. (Q22B)	
Contaminants	MCL[a]	Geom Mean	% Time Exceed MCL	Geom. Mean	% Time Exceed MCL	Geom Mean	% Time Exceed MCL
Trace Elements							
Arsenic	0.05	< 0.005	< 2	< 0.005	< 2	0.005	< 2
Barium	1.0	0.094	< 0.01	0.043	< 0.01	0.001	< 0.01
Cadmium	0.010	0.009	47	0.001	0.5	0.0001	< 0.01
Chromium	0.05	0.033	20	0.006	2	0.0008	0.4
Fluoride	1.6	1.4	28	0.73	0.4		< 0.01
Lead	0.05	0.005	0.1	0.004	4	0.0006	< 0.01
Mercury	0.002	0.0003	5	0.0006	5	0.0003	3
Nitrate (N)	10.	0.07	< 0.01	1.3	0.01	0.25	< 0.01
Selenium	0.01	< 0.005	2	<0.005	2	< 0.005	< 2
Silver	0.05	0.0016	< 0.01	0.0005	0.02	0.0002	< 0.01
Pesticides[b]							
Endrin	0.0002	< 0.00005	< 1	< 0.00005	< 2	< 0.00005	< 3
Lindane	0.004	0.00011	< 0.01	< 0.00005	< 2	< 0.00005	< 3
Methoxychlor	0.1	< 0.0001	< 1	< 0.0001	< 2	< 0.0001	< 3
Toxaphene	0.005	< 0.0003	< 1	< 0.0001	< 2	< 0.0001	< 3
2,4-D	0.1	< 0.0001	< 1	< 0.0001	< 2	< 0.0001	< 3
2,4,5-TP Silvex	0.01	< 0.0001	< 1	< 0.0001	< 2	< 0.0001	< 3
Radioactivity							
Radium 226 + 228	5pCi/1	NA[c]		NA		NA	
Gross Alpha	15pCi/1	0.87	0.1	0.42	< 0.01	0.48	1
Average Beta	4 mr/yr						
Other							
TTHM[d]	0.1	0.006	< 0.01	0.011	0.4	0.003	< 0.01
Turbidity	1 TU	NA		NA		NA	
Coliforms	1/100 ml	7×10^5	100	0.17	1	2.5	80

[a] mg/1 unless otherwise shown.

[b] Lindane was only pesticide detected in any sample, precent less than values for all but lindane based upon number of samples analyzed.

[c] NA - not analyzed.

[d] Annual average from the distribution system.

If none of the measured values exceeded the MCL, the percentage exceeded is shown as being less than the value of 100 divided by the number of analyses conducted. For example, if 50 analyses were conducted for a given constituent and no values exceeded the MCL, then we would conclude that the MCL would not be exceeded more than 100/50 or 2 percent of the time. The MCL may actually be exceeded much less than 2 percent of the time, but without making a greater number of analyses, one cannot be certain. All less-than values in the table were obtained in this way.

Table 43 indicates that only cadmium, chromium, fluoride, and coliforms exceeded the EPA interim primary drinking water MCL values in the influent water to WF21. Thus, the concentration of only these constituents would need to be lowered to meet these standards. Both WF21 effluents could meet these standards more than 95 percent of the time, except for coliforms in the RO effluent. The later problem could be corrected rather easily by normal disinfection of the RO effluent. This analysis indicates WF21 is quite reliable in meeting the EPA primary drinking water standards.

EPA SECONDARY DRINKING WATER STANDARDS

EPA has developed a group of secondary standards as listed in Table 44. These standards are not national requirements, but are suggested for control to preserve the aesthetic qualities of drinking water such as taste, odor, appearance, and corrosivity. Meeting of these standards is probably quite important for reclaimed water if it is to become generally acceptable for human consumption.

Several mineral constituents exceed the governing secondary maximum contaminant levels (SMCL) in the influent water to WF21. The drinking water supply used in Orange County generally has a high mineral content and this is increased significantly during usage. Few of the general mineral contaminants are changed significantly by the advanced treatment processes through GAC and chlorination, thus the chlorinated effluent at Q9 is little better in this respect than the influent water. Some contaminants such as color, odor, foaming agents, iron, and zinc are removed to a significant degree. Thus, this treatment improves the quality with respect to some, but not all, constituents.

Q9 quality was poorer with respect to some of the secondary standard constituents than Q1 water. This was the case with chlorides, copper, and pH. With copper, there was contamination between the GAC effluent (Q8) and the chlorination basin effluent (Q9). This may have been a result of contamination from the chlorine or from the coating used to prevent corrosion in the chlorine contact chamber. The Q9 pH was also generally quite low as a result of the high chlorine dosage used to achieve both disinfection and some degree of ammonia removal. The increased copper concentration is not a problem as far as the standards are concerned, and the low pH could be corrected readily by lime or other treatment.

RO treatment is used at WF21 primarily to improve the mineral quality of the reclaimed water. As indicated in Table 44, RO effluent met the secondary

TABLE 44. COMPARISON OF RECLAIMED WATER QUALITY WITH EPA SECONDARY DRINKING WATER MCL's JANUARY 1980 TO APRIL 1981

		Inf. (Q1)		Chlor Eff. (Q9)		RO Eff. (Q22B)	
Contaminant	SMCL[a]	Geom. Mean	% Time Exceed SMCL	Geom. Mean	% Time Exceed SMCL	Geom. Mean	% Time Exceed SMCL
Chloride	250	257	59	334	99	29	< 0.01
Color	15 CU	35	> 98	< 5	0.1	< 5	< 2
Copper	1	0.05	< 0.01	0.15	4	0.004	< 0.01
Corrosivity	non-corr	NA[b]		NA		NA	
Foaming Agents	0.5	0.24	6	< 0.10	< 2	< 0.10	< 2
Iron	0.3	0.11	14	0.05	0.3	0.003	0.4
Manganese	0.05	0.056	61	0.005	0.1	0.001	< 0.01
Odor	3 TON	NA[b]		NA		NA	
pH	6.5-9.5	7.5	< 0.5	5.3	81	6.9	3
Sulfate	250	301	79	273	61	1.4	< 0.01
TDS	500	1070	> 98	1010	> 98	82	< 0.1
Zinc	5	0.09	< 0.01	0.05	< 0.01	< 0.1	< 2

[a] mg/1 unless otherwise shown.
[b] NA - not analyzed.

standards more than 95 percent of the time. Thus, RO effluent would be suitable for a potable water supply if reliability in meeting the EPA primary and secondary drinking water standards were the only criteria used.

MEASURED VERSUS CALCULATED VALUES

In Tables 43 and 44, the values for percentage of time that the standards were exceeded were computed from the calculated geometric mean and spread factors when these data were available. From a regulatory point of view, such calculations may not be acceptable. Table 45 contains a comparison between the percentage of time the measured concentrations exceeded the EPA drinking water standards, and the percentage of time that was calculated from the lognormal distribution function when sufficient data was available. In general there is good agreement between the measured and calculated values.

It is felt that the calculated values give additional useful information. The predictions given by the calculation procedure help the reviewer to see which contaminants should be of little concern, and which need closer monitoring. For example, in the chlorinated effluent, neither barium nor cadmium ever exceeded the standards in 46 measurements. However, the calculations indicate barium is likely to exceed the standards less than 0.01 percent of the time, while cadmium is expected to exceed the standards 0.5 percent of the time. This suggests that monitoring for barium could be done at a much lower frequency than for cadmium. The calculated values can also help pick out anomalies in the data. For example, one sulfate value out of 163 exceeded the SMCL in RO effluent (0.6 percent), but based upon the calculations, sulfate would be expected to exceed the standards less than 0.01 percent of the time. The single high value appears to have resulted from analytical error or sample contamination since it is so out of line with all other values. The calculated percentage helps put this in proper perspective.

PRIORITY POLLUTANT HEALTH CRITERIA

Health criteria for drinking water have been developed for the priority pollutants as measured in this study (52). These criteria are based upon conservative assumptions, using results of animal studies. The health criteria are based upon the assumption that the consumer not only drinks the water but also consumes aquatic animals that live in the water. For compounds that are potential carcinogens, the concentration limit based upon health criteria is absolute zero. However, for such contaminants, concentrations associated with lifetime risks of 10^{-5}, 10^{-6}, and 10^{-7} have been specified. A 10^{-6} health risk means that if one million people consumed over a lifetime 2 liters of water per day by drinking or by eating food prepared with the water, the probability is that one person would develop cancer from the contaminant. The geometric mean concentrations determined for WF21 effluents after chlorination (Q9) and after reverse osmosis treatment (Q22B) are listed in Table 46 for comparison with the priority pollutant health criteria and with EPA primary and secondary drinking water standards.

Some of the drinking water standard concentrations are significantly higher than the health criteria concentrations. This is true for arsenic, chloroform, mercury, and toxaphene. This results because, in the development

TABLE 45. COMPARISON BETWEEN MEASURED AND PREDICTED PERCENTAGE OF TIME EFFLUENT QUALITY EXCEEDED EPA DRINKING WATER STANDARDS JANUARY 1980 TO APRIL 1981

	Chlor Eff (Q9)			RO Eff (Q22B)		
	Measured		Calc.[a]	Measured		Calc.[a]
	No. Exceed MCL/No. Measured	% Time Exceed MCL	% Time Exceed MCL	No. Exceed MCL/No. Measured	% Time Exceed MCL	% Time Exceed MCL
EPA Primary Drinking Water Standards						
Trace Elements						
Arsenic	0/46	<2	CC	0/51	<2	CC
Barium	0/46	<2	<0.01	0/51	<2	<0.01
Cadmium	0/46	<2	0.5	0/51	<2	<0.01
Chromium	2/46	4	2	0/51	<2	0.4
Fluoride	0/46	<2	0.4	0/54	<2	<0.01
Lead	2/46	4	4	0/51	<2	<0.01
Mercury	1/46	2	5	2/51	2	3
Nitrate (N)	0/41	<2	0.01	0/47	<2	<0.01
Selenium	0/46	<2	2	0/51	<2	CC
Silver	0/46	<2	0.02	0/51	<2	<0.01
Pesticides						
Endrin	0/54	<2	CC	0/35	<3	CC
Lindane	0/54	<2	CC	0/35	<3	CC
Methoxychlor	0/54	<2	CC	0/35	<3	CC
Toxaphene	0/54	<2	CC	0/35	<3	CC
2,4-D	0/54	<2	CC	0/35	<3	CC
2,4,5-TP Silvex	0/54	<2	CC	0/35	<3	CC
Radioactivity						
Gross Alpha	0/25	<4	<0.01	0/26	<4	1
Avg. Beta						
Other						
TTHM	0/27	<4	0.4	0/33	<3	0.01
Turbidity	NM			NM		
Coliforms	1/166	0.6	1	114/165	69	80
EPA Secondary Drinking Water Standards						
Chloride	128/134	96	99	0/180	<0.6	<0.01
Color	0/49	<2	0.1	0/56	<2	CC
Copper	0/46	<2	4	0/51	<2	<0.01
Foaming agents	0/43	<2	CC	0/50	<2	CC
Iron	1/46	2	0.3	0/51	<2	0.4
Manganese	0/46	<2	0.1	0/51	<2	<0.01
pH	127/143	89	81	7/166	4	3
Sulfate	88/132	67	61	1/163	0.6	<0.01
TDS	46/46	>98	>98	0/46	<2	<0.1
zinc	0/46	<2	<0.01	0/51	<2	<2

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[a] CC - Cannot calculate, most data below detection limit.

[b] Data from March 1978 to April 1981.

NM - Not measured.

TABLE 46. COMPARISON BETWEEN PRIORITY POLLUTANT HEALTH CRITERIA, DRINKING WATER STANDARDS, AND WF21 AVERAGE EFFLUENT QUALITY

		Health Criteria		EPA Drinking Water	Geom. Mean Conc. of WF21		
						Chlor.	RO
		Limit	10^6 lifetime Cancer Risk	MCL or SMCL	Detection Limit	Eff. (Q9)	Eff. (Q22B)
1.	Acenaphthene	20 µg/l			100 ng/l	ND	ND
2.	Acrolein	320 µg/l			NM	NM	NM
3.	Acrylonitrile	0	58 ng/l		NM	NM	NM
4.	Aldrin/	0	74 pg/l		50 ng/l	ND[b]	ND[b]
	Dieldrin	0	71 pg/l		50 ng/l	ND[b]	ND[b]
5.	Antimony	146 µg/l			NM	NM	NM
6.	Arsenic	0	2.2 ng/l	50 µg/l	5 µg/l	ND	ND
7.	Asbestos	0	30,000 Fibers/l		NM	NM	NM
8.	Benzene	0	660 ng/l		NM	NM	NM
9.	Benzidine	0	120 pg/l		NM	NM	NM
10.	Beryllium	0	6.8 ng/l		1 µg/l	410 ng/l	ND[b]
11.	Cadmium	10 µg/l		10 µg/l	100 ng/l	1.2 µg/l	70 ng/l
12.	Carbon tetrachloride	0	400 ng/l		50 ng/l	210 ng/l	60 ng/l
13.	Chlordane	0	460 pg/l		50 ng/l	ND[b]	ND[b]
14.	Chlorinated benzenes						
	Hexachlorobenzene	0	720 ng/l		10 ng/l	ND	ND
	1,2,4,5-tetrachlorobenzene	48 µg/l			10 ng/l	ND	ND
	Pentachlorobenzene	74 µg/l			10 ng/l	ND	ND
	Trichlorobenzene	a	a		10 ng/l	70 ng/l	70 ng/l
	Monochlorobenzene	488 µg/l			10 ng/l	70 ng/l	70 ng/l

(Continued)

TABLE 46 (Continued)

	Health Criteria		EPA Drinking Water MCL or SMCL	Geom. Mean Conc. of WF21		
	Limit	10^6 lifetime Cancer Risk		Detection Limit	Chlor. Eff. (Q9)	RO Eff. (Q22B)
15. Chlorinated ethanes						
1,2-Dichloroethane	0	940 ng/1		50 ng/1	ND	ND
1,1,1,trichloroethane	18.4 mg/1			50 ng/1	180 ng/1	50 ng/1
1,1,2-trichloroethane		600 ng/1		50 ng/1	ND	ND
1,1,2,2-tetrachloroethane		170 ng/1		50 ng/1	ND	ND
Hexachloroethane		1.9 µg/1		50 ng/1	ND	ND
1,1-Dichloroethane	a	a		50 ng/1	ND	ND
1,1,1,2-tetrachloroethane	a	a		50 ng/1	ND	ND
Pentachloroethane	a	a		50 ng/1	ND	ND
16. Chloroalkyl ethers	0	3.8 pg/1		100 ng/1	ND[b]	ND[b]
17. Chlorinated napthalene	a	a		100 ng/1	ND	ND
18. Chlorinated phenols						
2,4,6-trichlorophenol[d]	0	1.2 µg/1		50 ng/1	ND	ND
19. Chloroform	0	190 ng/1	100 µg/1	50 ng/1	10 µg/1	1.8 µg/1
20. 2-chlorophenol	100 ng/1			50 ng/1	ND	ND
21. Chromium						
Cr(III)	170 mg/1					
Cr(VI)	50 µg/1		1 mg/1	100 ng/1	6.5 µg/1	820 ng/1
22. Copper	1 mg/1		1 mg/1	100 ng/1	154 µg/1	3.9 µg/1
23. Cyanides	200 µg/1			100 ng/1	9 µg/1	2 µg/1

(Continued)

TABLE 46 (Continued)

		Health Criteria		EPA Drinking Water MCL or SMCL	Geom. Mean Conc. of WF21		
		Limit	10^6 lifetime Cancer Risk		Detection Limit	Chlor. Eff. (Q9)	RO Eff. (Q22B)
24.	DDT	0	24 pg/1		50 ng/1	ND^b	ND^b
25.	Dichlorobenzene	400 μg/1			10 ng/1	100	60 ng/1
26.	Dichlorobenzidine	0	10 ng/1		NM	NM	NM
27.	Dichloroethylenes	0	33 ng/1		20 ng/1	ND	ND
28.	2,4-Dichlorophenols	3.1 mg/1			50 ng/1	ND	ND
29.	Dichloropropanes/ propenes	87 μg/1			50 ng/1	ND	ND
30.	2,4-Dimethylphenol	2.1 mg/1			50 ng/1	ND	ND
31.	Dinitrotoluene	0	110 ng/1		100 ng/1	ND	ND
32.	Diphenylhydrazine	0	42 ng/1		100 ng/1	ND^b	ND^b
33.	Endosolfan	74 μg/1			NM	NM	NM
34.	Endrin	1 μg/1		200 ng/1	50 ng/1	ND	ND
35.	Ethylbenzene	1.4 mg/1			10 ng/1	20 ng/1	40 ng/1
36.	Fluoranthene	42 μg/1			20 ng/1	ND	ND
37.	Haloethers	a	a		100 ng/1	ND	ND
38.	Halomethanes	0	190 ng/1	100 μg/1	50 ng/1	8 μg/1	1.7 μg/1
39.	Heptachlor	0	280 pg/1		50 ng/1	ND^b	ND^b
40.	Hexachloro- butadiene	0	450 ng/1		100 ng/1	ND	ND
41.	Hexachloro- cyclohexane[f]	0	9.2 ng/1		50 ng/1	ND^b	ND^b
42.	Hexachloro- cyclopentadiene	1.0 μg/1			100 ng/1	ND	ND

(Continued)

TABLE 46 (Continued)

	Health Criteria		EPA Drinking Water MCL or SMCL	Geom. Mean Conc. of WF21		
	Limit	10^{6} lifetime Cancer Risk		Detection Limit	Chlor. Eff. (Q9)	RO Eff. (Q22B)
43. Isophorone	5.2 mg/l			100 ng/l	ND	ND
44. Lead	50 µg/l		50 µg/l	100 ng/l	4 µg/l	650 ng/l
45. Mercury	144 ng/l		2 µg/l	500 ng/l	570 ng/l	280 ng/l
46. Naphthalene	a	a		20 ng/l	30 ng/l	60 ng/l
47. Nickel	13.4 µg/l			1 µg/l	19 µg/l	1.5 ng/l
48. Nitrobenzene	19.8 mg/l			100 ng/l	ND	ND
49. Nitrophenols	13.4 µg/l			50 ng/l	ND	ND
50. Nitrosamines^{g}	0	0.8 ng/l		NM	NM	NM
51. Pentachlorophenol	30.0 µg/l			50 ng/l	50 ng/l	50 ng/l
52. Phenol	300 µg/l			50 ng/l	ND	50 ng/l
53. Phthalate esters^{h}	15 mg/l			100 ng/l	1.7 µg/l	1.7 µg/l
54. Polychlorinated biphenyls (PCBs)	0	790 pg/l		50 ng/l	50 ng/l^{b}	ND^{b}
55. Polynuclear aromatic hydrocarbons	0	2.8 ng/l		20 ng/l	ND^{b}	ND^{b}
56. Selenium	10 µg/l		10 µg/l	5 µg/l	5 g/l	ND
57. Silver	50 µg/l		50 µg/l	100 ng/l	480 ng/l	150 ng/l
58. Tetrachloroethylene	0	800 ng/l		50 ng/l	710 ng/l	80 ng/l
59. Thallium	13 µg/l			NM	NM	NM
60. Toluene	14 mg/l			10 ng/l	390 ng/l	130 ng/l
61. Toxaphene	0	710 pg/l	5 µg/l	50 ng/l	ND	ND

(Continued)

Table 46 (Continued)

	Health Criteria		EPA Drinking Water MCL or SMCL	Geom. Mean Conc. of WF21		
	Limit	10^6 lifetime Cancer Risk		Detection Limit	Chlor. Eff. (Q9)	RO Eff. (Q22B)
62. Trichloroethylene	0	2.7 μg/1		50 ng/1	60 ng/1	10 ng/1
63. Vinyl chloride	0	2.0 μg/1		NM	NM	NM
64. Zinc	5 mg/1		5 mg/1	100 μg/1	53 μg/1	< 100 μg/1
65. 2,3,7,8-tetrachloro-dibenzo-p-dioxin	0	210×10^{-9} ng/1		50 ng/1	ND[b]	ND[b]

[a]-Insufficient information is available upon which to make a determination.

[c]-Detection limit is estimated from that of similar compounds.

[d]-Other chlorinated phenols have higher limits or else insufficient data is available to make determination.

[e]-Limit for 1,1-dichloroethylene, other dichloroethylenes have higher limits or else insufficient data is available to make determination.

[f]-Limit for lindane, value is higher for other hexachlorocyclohexanes, but none detected in sample.

[g]-Limit for n-nitrosodiethylamine, other nitrosamines have higher limits.

[h]-Limit for bis(2-ethylhexyl)phthalate, other pthalates have higher limits.

ND - Not detected in samples.

ND[b] - Detection limit is above criteria level.

NM - Not measured.

Underlined - Concentration exceeds either the health criteria or the MCL or SMCL, whichever governs.

of drinking water standards, economics and technical feasibility are considered in addition to health criteria. For the purpose of comparison, the drinking water standards are considered to govern with all priority pollutants for which such standards have been developed. In all other cases, the health criteria are considered to govern. In addition, the criteria for 10^{-6} lifetime cancer risk are considered to be applicable. These criteria offer a reasonable level of protection considering all the uncertainties in the criteria.

As indicated in Table 46 and as discussed in Section 5, 11 of the 65 groups of priority pollutants were not measured in this study and so no comparisons can be made for them. Eight of these are organic compounds and three are inorganic elements. In addition, the analytical detection limits for 11 priority pollutants were well above the health criteria upper limits. Thus, no judgements can be made as to whether or not the reclaimed water met these criteria. In many other cases, the detection limits were close to the health criteria and the evaluation of whether WF21 meets these criteria is associated with significant uncertainty. It is apparent that serious analytical limitations exist in assessing health risks at the levels indicated for some potential human carcinogens. An extreme example of this is 2,3,7,8-tetrachlorodibenzo-p-dioxin with a 10^{-6} lifetime cancer risk at 210×10^{-9} ng/l, a concentration which is far too low to be detected.

For the 43 priority pollutants for which a valid comparison can be made and based upon geometric mean effluent concentrations, the chlorinated effluent (Q9) met all but two criteria and the reverse osmosis effluent (Q22B) met them all. The two priority pollutants not meeting the criteria in the chlorinated effluent were the inorganic elements beryllium and nickel.

RELIABILITY SUMMARY

WF21 is quite reliable in meeting EPA drinking water standards. Treatment through GAC and final chlorination produced a water that met the primary MCL values more than 95 percent of the time. This treatment also met many of the SMCL values with this or better frequency except for pH and those parameters associated with general mineral content, such as TDS, chlorides, and sulfates. The above treatment plus the use of RO for demineralization results in a water that can meet EPA primary and secondary standards more than 95 percent of the time. The chlorinated effluent without RO treatment also met health criteria for almost all priority pollutants for which data was sufficient to judge except for two inorganic elements. RO treatment reduced the concentration of all priority pollutants for which data was available below the criteria level. However, reliability in meeting the EPA standards and perhaps priority pollutant health criteria is a necessary but not sufficient condition for accepting the effluent from WF21 as a direct source of potable water. Severe analytical limitations exist for assessing the risk of some cancer-causing chemicals. Therefore, it is generally felt by state and federal health authorities that additional toxicity testing is required.

AVAILABILITY

Another aspect of reliability is the ability of a plant to operate without failure. In the case of WF21, there was no necessity to treat nor to inject water at all times. Whenever an equipment failure occurred, the plant could be shut-down for repair. Also, the plant could be shutdown on a planned basis for general maintenance. However, for some other reclamation plants such luxury may not be available, and a reclamation plant may need to operate continuously. This would require more redundancy and thus higher equipment and maintenance costs than experienced with WF21. In any event, availability of a reclamation plant for operation is of interest since it affects the cost of treatment.

Detailed records are available for WF21 that outline items of maintenance and repair. Some equipment failures require shutdown of some or all processes, some can be handled by reducing flow to some processes, and others require no reduction at all in flow through the treatment plant. For example, the RO tubes can be replaced in one section at a time without reducing the flow to the other five sections. Thus no shutdown would be required, but flow through the RO system would be reduced somewhat. Outlined in this section are only items that resulted in shutdown of the AWT plant (Q1 through Q9) or the RO plant (Q1 through Q22B). However, all major items of repair and overall costs for maintenance and repair for a one-year period of operation (1980-1981) are described in Section 12 on Costs.

There were 1127 days between March 1, 1978 and March 31, 1981, the period of operation covered by this report. Table 47 outlines chronologically by month the number of days when the AWT and/or the RO plants were not operated. Also included are reasons for the shut-downs. Table 48 is a summary of shut-downs by cause and includes the distribution as a percentage of shut-down time and overall time.

The AWT plant was operated about 73 percent of the time and the RO plant about 90 percent of the time. There were two major items that reduced the AWT plant operation, both occurring within the first one and one-half years of this study. The first was repair of the final chlorination basin. Flow to the basin was initially stopped during the first three months of this study to remove activated carbon that was lost from the GAC columns when they were operated in an upflow manner. It was then discovered that the lining on the basin was damaged. About three months were spent in determining the cause and effecting the repair. The activated carbon columns were also modified for downflow operation to prevent future spills.

During 1979 it was decided to evaluate flow velocities in the groundwater zones impacted by injection, and so an evaluation by the Geology Department was undertaken. In order to do this, flow through the chlorination basin was discontinued and water from RO treatment only was injected into the ground. This provided a mineral-free water that could serve as a tracer for movement in the ground.

TABLE 47. CHRONOLOGY OF AND REASONS FOR PLANT SHUTDOWN

	AWT (Q1-Q9)		RO (Q1-Q22B)	
Month	Days of Shutdown	Reasons for shutdown	Days of Shutdown	Reasons for shutdown
1978				
Apr	27	chlor basin repair	7	acid leak and lime slaker down
May	31	chlor basin repair	7	acid leak, flow cont valve
Jun	30	chlor basin repair	13	acid leak, chlor sys repair
Jul	12	carbon col mod	12	chlor sys repair
Aug			2	RO sump contr repr
Oct	5	therm disc cooler repair		
Dec	4	therm disc cooler repair		
1979				
Jan	8	clean-up, low on lime		
Feb	4	low on lime, pump failure	3	pump failure
Apr	25	geol dept study		
May	31	geol dept study	3	line leak
Jun	27	geol dept study		
July	6	convey repair	6	convey & SHMP feed repair
Aug	7	rotary air lock repair	6	panel repair
Sep	1	general repair	1	general repair
Dec	1	lack of lime	2	lack of lime
1980				
Jan	17	convey repair	11	check orifice, acid leak
Mar	2	elect repair	2	elect repair
Apr			17	genrl main and repair
May	12	genrl main	4	genrl main and repair
Jun	4	genrl main	4	genrl main
Jul	2	convey main	2	convey repair
Aug	5	genrl main	5	genrl repair
Sep	1	power shutoff	1	power shutoff
Oct	3	power shutoff	3	power shutoff
Dec	21	genrl main	21	genrl main
1981				
Jan	20	genrl main	23	genrl main
Feb	1	no infl water avail	5	pipe mod, no infl water avail
Mar			7	acid leak

The groundwater study and the chlorine basin repair are unusual events which do not reflect on the normal availability of the AWT plant. If these events are removed, then the AWT plant was available about 88 percent of the time or nearly the same availability as the RO plant. Of this, about one-half of the shutdown time was for planned routine maintenance and the other one-half was the result of equipment failures.

TABLE 48. PERCENTAGE OF TIME PLANT SHUTDOWN DUE TO VARIOUS CAUSES

	AWT			RO		
		Percentage of			Percentage of	
Cause of Down Time	Days	Down Time	Total Time	Days	Down Time	Total Time
Geological Dept. Study	83	27	7.4			
Chlorine Basin Repair	88	28	7.8			
Carbon Column Modif.	12	4	1.1			
General Maintenance	57	19	5.1	60	34	5.3
External Causes*	18	6	1.6	5	3	0.4
Other Equip. Failures	49	16	4.4	111	63	5.6
Total	307	100	27.4	176	100	11.3

*Power shutoff, no influent water available, lack of chemicals.

SECTION 12

WATER FACTORY 21 COSTS

INTRODUCTION

The purpose of this section is to present detailed cost data on the operation of the processes at WF21 during fiscal year 1980-81. The cost of reclaiming water is a question which is more frequently asked as increased water demands exert more pressure on existing conventional water supplies, and WF21 provides an excellent opportunity for those studying the feasibility of reclaiming wastewater to evaluate the costs at a full scale operating facility. The water available for reclamation at WF21 is a municipal activated sludge effluent. Primary and biological secondary treatment are provided by the County Sanitation Districts of Orange County (CSDOC) and are required even without reuse; therefore, these processes have not been included in calculating the cost of wastewater reclamation.

During fiscal year 1980-81, WF21 produced a total of 5.34 x 10^6 m^3 of reclaimed water. Table 49 shows the quantities of water treated and produced by the AWT and RO processes. The majority of AWT water (without final chlorination) was used as feed to the RO system so that the amount produced (with final chlorination) is much lower than that treated. Also shown in Table 49 is the total amount of deep well blending water added to the reclaimed wastewater flows. Since the water produced is recharged into the groundwater supply, the injection water quality criteria established by the the Regional Water Quality Control Board require blending the AWT effluent with an equal amount of either RO water, deep well water, or some combination of these. The unit cost for each type of water is calculated on the basis of actual production achieved during the year. Unit costs have increased from the 1979-80 fiscal year because the average quantity of water treated, particularly by the AWT processes, was considerably less than design flows, which are 57,000 m^3/d for AWT and 19,000 m^3/d for RO.

The OCWD decided to reduce the operating capacity of WF21 during the year because recent winter rains have provided considerable natural recharge water, reducing the injection barrier demand. While diminished production increases unit costs, total annual expenditures are less because of energy savings, lower treatment chemical requirements and reduced maintenance costs, and an overall savings is realized.

The AWT plant treated an average of 20,400 m^3/d during the year. Of this quantity 17,400 m^3/d was treated by the reverse osmosis plant, producing an average of 14,700 m^3/d for injection. The remaining 3,000 m^3/d AWT water was blended with the RO effluent and deep well water. This reduced flow during

TABLE 49. WATER FACTORY 21
WATER TREATED AND PRODUCED DURING FISCAL YEAR 1980-81 ($10^6 m^3$)

	AWT	RO	Deep Well	Total
Treated	6.12	5.24		11.36
Produced	0.89	4.45	4.64	9.98

the year increased the unit cost of the water produced, since many of the costs associated with operation of WF21 (such as labor) are fixed, not variable. However, the data reflect the entire one-year period without cost adjustment and are based on the total dollar expenditure divided by the total quantity of water produced. Thus the cost data given represent actual operating conditions for a full scale operating AWT facility during fiscal year 1980-81. In an attempt to determine a more representative cost of reclamation, the actual unit costs were used to project costs for design flow operations. These projections are given in the summary of this section and can be used by water planners interested in studying the cost of AWT.

During the period when the cost data were collected, WF21's blended injection water met all the requirements shown in Table 42 (Section 11) with only a few minor exceptions. The performance and reliability of the facility are discussed in detail in Section 11 and will not be repeated here.

CAPITAL COSTS

A breakdown by treatment process for both AWT and RO plant capital costs is given in Table 50. Construction cost for the AWT plant and injection facilities, started in March of 1972, was $13.2 million. The 19,000 m^3/d (5 mgd) RO plant, begun in 1975, was constructed at a cost of $3 million. Capital expenditures include all equipment and construction costs and all design and construction engineering costs. These reflect the actual construction bid award prices and have not been adjusted for inflation. The capital cost for each facility includes site work, landscaping, electrical work, and yard piping. All capital costs reported herein have been amortized over a service life of 20 years at 7% interest. The annual amortized captial cost has been divided by the quantity of water produced by both facilities during fiscal year 1980-81 to give a unit captial cost. Those facilties which are partially common to the specific processes were charged to the individual treatment operations according to their precentage of the total investment.

OPERATING COSTS

Monthly operating costs were accumulated during the last year of plant operation (fiscal year 1980-81). These costs were then segregated and assigned to each individual unit process associated with the expenditure. Then the total annual operating cost for each process was divided by the amount of water produced during the year to calculate unit costs.

TABLE 50. WF21 CAPITAL AND ENGINEERING COSTS

Treatment Process	Sub-Component Costs	Total Component Costs
Influent pipeline & pump station		$ 371,000
Lime clarification		826,000
Ammonia stripping		3,094,000
Recarbonation		421,000
Filtration		946,000
Granular activated carbon		3,307,000
Adsorption	$ 1,432,000	
Regeneration Furnace	489,000	
Building, Controls and Other equipment	1,386,000	
Chlorination		396,000
Solids Handling		1,848,000
Sludge pump station	109,000	
Thickener	57,000	
Centrifuges	135,000	
Furnace	600,000	
Building, controls, piping, electrical and other	947,000	
Reverse osmosis plant		3,000,000
Blending reservoir injection system		2,055,000
TOTAL CAPITAL COST		$16,264,000

Note: Site work, landscaping, electrical work, and yard piping are included in the cost of individual treatment operations according to their percentage of total capital cost. Land costs are not included. Costs shown are actual construction costs and are not adjusted for inflation.

The total monthly salary cost for operations and maintenance reflects actual salaries, including all benefits. The method used to allocate labor to the various treatment processes was to assign a fixed percentage based on the actual plant operating records, which reflect the amount of time spent by operations and maintenance personnel on each process (see Table 51).

WF21, requiring 19 operators, is operated on a shift basis with three shifts providing continuous seven day per week operation. Operation salaries also include some engineering and administrative costs associated with operating the facility. Maintenance is performed by a staff of twelve on a day shift only, five day per week basis. Included in the maintenance department are three electrical and instrumentation technicians. Utility costs are based on actual expenditures during one year of operation. Power requirements

TABLE 51. ALLOCATION OF OPERATIONS AND MAINTENANCE LABOR PER TREATMENT PROCESS

Treatment Process	Percent of Time Operations	Maintenance
Influent pumping/lime clarification	15	11
Ammonia stripping#	2	2
Recarbonation/breakpoint chlorination	6	8
Mixed media filtration	6	2
Activated carbon adsorption	6	5
Carbon regeneration	10	14
Post-chlorination	6	7
Solids handling	30	35
Reverse osmosis demineralization	15	5*
Injection system	2	9
Deep well blending	2	2
Total	100	100

*Most of the maintenance for the reverse osmosis system was done under contract with Fluid Systems Division, UOP, Inc.
#Modified operation with fans not in use since April 1978.

were determined by actual field measurements during operation of each individual unit process, and monthly electrical utility costs were allocated in accordance with the results of the field measurements. Gas consumption is metered separately for the lime and carbon systems, thus enabling direct use of utility bills for determining these costs.

Chemical costs, based on chemicals actually used during one year's operation, include freight delivery charges. Records are maintained on chemical consumption for individual unit processes, thereby allowing allocation of these costs.

Detailed cost records were maintained on all maintenance materials purchased for plant operations during the fiscal year. These costs include equipment rentals, uniform expense for all plant and maintenance personnel, and small tool expense as well as replacement parts and materials. The total yearly maintenance costs were then assigned to the various unit processes. Most major maintenance activities and modifications are mentioned in the sections on costs for the individual unit processes. The average unit costs of the various operating commodities used in operation of WF21 are shown in Table 52. The total annual cost of operation and maintenance is summarized in Table 53.

TABLE 52. WATER FACTORY 21
UNIT OPERATING COSTS

Chemical	
Lime	7.03¢/kg
Cl_2	24.00¢/kg
H_2SO_4	6.43¢/kg
Polymer	$1.20/kg
SHMP	$0.23/kg
Carbon	$0.30/kg
Energy	
Electricity	5.80¢/Kw-hr
Gas	34.90¢/Therm

TABLE 53. WATER FACTORY 21 ANNUAL COST OF OPERATIONS AND MAINTENANCE
AWT PLANT, RO PLANT, INJECTION SYSTEM

Salaries		$ 897,289
Operations	$ 534,333	
Maintenance	362,956	
Utilities		895,653
Electricity	767,296	
Gas	128,357	
Chemicals		243,075
Lime	78,313	
Polymer	3,159	
Sulfuric acid	53,205	
Chlorine	48,197	
Sodium hexametaphosphate	36,801	
Activated carbon	23,400	
Maintenance		473,557
Parts and Materials	163,165	
Equipment rentals	16,000	
RO maint. contract	229,892*	
Tools	7,500	
Clothing, training, vehicles, grounds	57,000	
TOTAL ANNUAL O & M COST		$2,509,574

*RO maintenance contract includes all membrane replacement costs, cartridge filter replacement, membrane cleaning, and routine preventative emergency maintenance.

COST OF INDIVIDUAL AWT PROCESSES AT WF21

Influent Pumping/Lime Clarification

The secondary effluent from CSDOC'S Plant No. 1 is pumped to WF21 by an influent pump station at a constant rate. Two pumps, each capable of providing 0.44 m^3/s through a 0.76 m diameter pipeline and flow control valve, maintain a constant flow into the chemical clarifier/rapid mix basin.

Chemical clarification is accomplished in separate rapid mix, flocculation, and sedimentation basins. Lime, which is used as a primary coagulant, is fed automatically to achieve an optimum treatment pH of 10.8 - 11.0 and is added in slurry form to the rapid-mix chamber. A polymer dose of 0.2 mg/l is added to the water between the second and third flocculation basins to improve solids separation.

Table 54 shows the specific operating and capital costs for influent pumping and lime clarification. Associated with these costs are the influent pumps, the lime storage bins, lime slakers/feeders, flocculators, clarifiers, and polymer feed system. Sludge draw-off, thickening, and all solids handling are incuded in the cost of sludge recovery/lime recalcination.

Maintenance labor and repair costs associated with the influent pump station and lime clarifier during the year include overhaul of influent pump; cleaning of flocculator basin and modification of the liquid-lime system's piping, pump, and control equipment; and replacement of sludge draw-off valves and regulators, instrument air compressor, scraper gear reducer, and flocculator bearing.

TABLE 54. WATER FACTORY 21 OPERATING AND CAPITAL COSTS
INFLUENT PUMPING/LIME CLARIFICATION

	$\$/10^3 m^3$	
Capital		18.45
Operating		43.62
Operation labor	13.35	
Maintenance labor	6.84	
Electricity	5.24	
Lime	12.79	
Polymer	0.51	
Maint. materials	4.89	
TOTAL		62.07

Solids Handling/Lime Recalcination

The lime sludge is pumped from the chemical clarifier to a gravity thickener for solids concentration and then to two solid bowl centrifuges for further dewatering. The lime cake from the centrifuges is fed into a multiple hearth, gas fired furnace for recalcination. This furnace is 6.8 m in diameter, with a capacity of 0.5 kg/s of CaO, and is operated at 950°C. Following cooling of the recalcinated lime, it is conveyed by bucket elevator to the lime storage bins for future use. During fiscal year 1980-81 the lime furnace reprocessed about 1480 Mg of lime at an operating cost of approximately $460/Mg (megagrams) of CaO recalcined. Operating and capital costs for the lime solids handling system are shown in Table 55.

Maintenance labor and repair costs associated with solids handling and lime recalcining during the year included replacement of steam ejector drain piping, conveyor drive motor, two pump motors ruined by flooding, rapid mix controller, lime-bin sleeves, dust filters, felt packing on vertical drive head, conveyor shear pins, and pump bearings; installation of new centrate line, furnace center shaft gear box, and horizontal conveyor screws; fabrication of new conveyor hopper; repair of rapid mix analyzer; retiling of centrifuge conveyor; and repeated unplugging of vertical conveyor and mud pumps.

TABLE 55. WATER FACTORY 21 OPERATING AND CAPITAL COSTS
LIME SOLIDS RECOVERY SYSTEM

	$/10^{3}m^3	
Capital		28.48
Operating		91.51
Operations labor	26.71	
Maintenance labor	21.67	
Electricity	6.87	
Gas	19.27	
Maint. materials	16.99	
TOTAL		119.99

Air Stripping

Originally the effluent from the chemical clarifiers was pumped to the ammonia stripping towers for ammonia nitrogen removal. Ammonia stripping was accomplished in countercurrent induced draft towers at about 3000 m^3 air per m^3 of wastewater. Average ammonia removal efficiency ranged from 50% to 80%, depending upon several variables, with air temperature the most important factor. The ammonia stripping process includes four constant speed pumps and two countercurrent flow cooling towers equipped with six 5.5-m diameter fans powered by two-speed electric motors (125 or 155 hp).

Since the plant was being operated at reduced flow, the ammonia removal system was not needed for almost the entire period of this study because almost all the water being treated was receiving reverse osmosis demineralization, which removes ammonia. The water was pumped through the towers, however, because earlier studies showed that, even without forced draft ventilation, the stripping towers were most effective in removing specific low molecular weight volatile organics. Therefore, during this study the towers were operated as air strippers, without the fans, for organics removal. Operation and capital costs for the air stripping towers, without operating the fans, are given in Table 56. Operation without fans reduces the electric consumption about 33,000 kWh/day. At the current power rate, 5.80¢/kWh, this represents a savings of $\$34/10^3 m^3$ power costs. If ammonia removal by air stripping were to be practiced, the cost would be increased by the latter amount.

TABLE 56. WATER FACTORY 21 OPERATING AND CAPITAL COSTS
AIR STRIPPING

		$\$/10^3 m^3$
Captial		47.68
Operating		11.01
Operations labor	1.78	
Maintenance labor	1.14	
Electricity	7.42	
Maint. materials	0.67	
TOTAL		58.69

Build-up of calcium-carbonate scale within the fill bundles was minimal, and very little maintenance was required when the fans were not operated. There were various piping repairs made during the year of cost evaluations, and the distribution pipes were cleaned after removal of spray nozzles from the second tower.

Recarbonation

Following air stripping, carbon dioxide is added to the water in the recarbonation basin to lower the pH to approximately 7.5. Recooled, compressed, scrubbed stack gases from the lime recalcining furnace provide the carbon dioxide used in the recarbonation basin.

In addition to pH adjustment, 5-8 mg/l of chlorine is also added to provide partial disinfection and algae control. Table 57 gives the cost of single-stage recarbonation. When carbon dioxide is not available, operation of the standby acid system gives proper pH control. Most maintenance costs incurred during the year were associated with sandblasting and coating of launders, replacement of the chlorine line, and repairs to the CO_2 compressors.

TABLE 57. WATER FACTORY 21 OPERATING AND CAPITAL COSTS SINGLE-STAGE RECARBONATION SYSTEM

	$\$/10^3 m^3$	
Capital		6.49
Operating		23.33
Operations labor	5.34	
Maintenance labor	4.56	
Electricity	3.91	
Standby acid	2.75	
Cl_2	3.25	
Maint. materials	3.52	
TOTAL		29.82

Mixed-Media Filtration

The wastewater from the recarbonation basin flows by gravity to one of four open, gravity flow, mixed-media filter beds consisting of coarse coal, silica and garnet sand. The beds are designed for a 0.2 m/min loading rate with provisions for alum and polymer addition to improve clarification. Because of the high quality of the water filtered, alum and polymer addition is not required. A typical filter run is over two weeks. Average filter effluent turbidity during the past year of operation has been 0.2 TU.

Operating and capital costs for the mixed media filtration system are shown in Table 58. Operating labor includes manually initiating filter backwash, periodic monitoring of the filtration and backwash cycles, general cleaning, and equipment servicing. Maintenance cost this year included overhauling one pump and repairing the seal on another, as well as cleaning the backwash tank. The plant air compressors required replacement of intake, exhaust and unloading valves, twice each; overhaul of compressor heads; and repair of two underground pipe leaks. (The cost of maintaining the air compressors has been distributed among all plant processes, as this equipment is used for all the treatment systems.)

Activated Carbon Adsorption

After filtration, the water is pumped to the top of the downflow activated-carbon contactors, which are designed with an empty-bed contact time of 34 minutes and operate at a loading rate of 0.2 m/min (5 gpm/ft^2). There are 17 granular activated carbon (GAC) columns, each filled with approximately 36,000 kg of 8 x 30 mesh GAC. Long term operation of the carbon system has removed about 60% of the applied COD and produced an effluent with an average COD of 8.8 mg/l.

TABLE 58. WATER FACTORY 21 OPERATING AND CAPITAL COSTS
MIXED MEDIA FILTRATION

	$\$/10^3m^3$	
Capital		14.58
Operating		8.06
Operations labor	5.34	
Maintenance labor	1.14	
Electricity	0.78	
Alum	--	
Polymer	--	
Maint. materials	0.80	
TOTAL		22.64

Operating and capital costs for activated carbon adsorption are shown in Table 59. Operational labor includes flow monitoring, sampling, and periodic backwash of columns. Maintenance costs include repair or replacement of various valves, as well as problems related to carbon spills prior to installation of a new transfer system. The initial carbon charge for the carbon adsorption system is included under capital costs.

TABLE 59. WATER FACTORY 21 OPERATING AND CAPITAL COSTS
ACTIVATED CARBON ADSORPTION

	$\$/10^3m^3$	
Capital		36.12
Operating		19.39
Operations labor	5.34	
Maintenance labor	2.84	
Electricity	9.02	
Maint. materials	2.19	
TOTAL		55.51

Activated Carbon Regeneration

Spent carbon from the carbon adsorption system is thermally regenerated on site by means of a gas-fired multiple-hearth furnace with a capacity of 0.063 kg/s (500 lb/hr), dry basis, of activated carbon. A steam boiler provides steam on hearths 4 and 6, which are fired at a rate of one kg steam per kg carbon, and the spent carbon is regenerated at 900° to $950^{\circ}C$. Following regeneration, the activated carbon is washed, defined and returned to the carbon contactors. Carbon losses have averaged less than 10%. During fiscal 1980-81 the carbon furnace was operated slightly less than 16% of the time, and 164,000 kg of carbon were regenerated. This represents a regeneration cost of about $1.20/kg.

Based on a carbon loss of approximately 10%, the makeup carbon requirement for this operational period is approximately 16,400 kg. At the most recent (1980) estimated purchase price of $1.43/kg, the cost would be $23,400. Although this carbon was not actually purchased, its cost has been included in the O & M costs for activated carbon regeneration given in Table 60.

Operational costs include furnace operation, defining, transferring spent and regenerated carbon, and regeneration efficiency analysis. Maintenance labor and repair costs associated with the activated carbon regeneration system during the year include replacement of the steam boiler, one slurry transfer pump, one furnace hearth, steam injectors, center shaft drive clutch, and furnace sand seal; overhaul of one slurry transfer pump and the auxiliary cooling shaft engine; and modification of the carbon transfer valve. Sand was replaced in all hearths after cleaning of the furnace.

TABLE 60. WATER FACTORY 21 OPERATING AND CAPITAL COSTS ACTIVATED CARBON REGENERATION

	$\$/10^3 m^3$	
Capital		13.39
Operating		31.74
Operations labor	8.90	
Maintenance labor	8.55	
Electricity	3.17	
Gas	1.59	
Maint. materials	5.71	
Carbon	3.82	
TOTAL		45.13

Final Chlorination

Following activated carbon treatment, a portion of the carbon treated water flows to the final chlorination basin for disinfection. The remaining portion of the flow goes to the 0.22 m^3/s (5 mg) RO demineralization plant for further treatment. During final chlorination a dose of 15-20 mg/l of chlorine is applied. This high dosage insures complete disinfection and provides destruction of bacteria and virus. Coliform counts for the final chlorinated effluent are below the detection limit. In addition, this high chlorine dose provides some oxidation of remaining ammonia nitrogen and ensures that when the AWT plant effluent is blended with well water and demineralized activated carbon effluent, a chlorine residual is provided prior to injection.

During the cost year, most of the water treated was diverted into the RO plant with only a small amount of overflow actually going through this last AWT treatment process. Because very little water was actually chlorinated in this final step, unit costs for both captial and O & M would be quite high if they were based on the amount of flow actually chlorinated. Therefore, since chlorine is used throughout the AWT plant in locations such as the recarbonation basin and injection system, costs for the chlorination step have been based on the AWT total plant flow of 6.1 x $10^6 m^3$ for the year. Only the chemical cost shown in Table 61 reflects the amount of chlorine added to treat 0.89 x $10^6 m^3$, the actual throughput of the final chlorination basin itself.

Operating costs for final chlorination, shown in Table 61, include monitoring chlorine feed rates, loading and unloading chlorine cylinders, and routine maintenance of chlorine analyzers. Maintenance costs include replacement of the chlorine evaporator and the dock manifold piping and valves, as well as repair of the injectors.

TABLE 61. WATER FACTORY 21 OPERATING AND CAPITAL COSTS CHLORINATION

	$/$10^3 m^3$	
Capital		3.58
Operating		14.82
Operations labor	5.34	
Maintenance labor	4.56	
Electricity	1.49	
Chlorine	0.81*	
Maint. materials	2.62	
TOTAL		18.40

*Unit cost shown for chlorine is low because of low portion of plant flow (0.89×10^6 m^3) receiving final chlorination. All other cost categories reflect unit costs based on treating 6.1×10^6 m^3 with chlorine at three different locations in the treatment plant.

Reverse Osmosis Demineralization

That water which does not flow to the final chlorination basin is diverted to the 0.22 m^3/s (5 mgd) RO plant for demineralization. The RO system includes pretreatment with chlorine addition, scale inhibitor feed, and cartridge filtration. The water is then pumped by two high pressure feed pumps (900 hp) to an operating pressure of 39 kg/cm^2 (550 psi). Downstream of the high pressure feed pumps, acid is injected to adjust pH to 5.5, and the water then passes to the membrane assemblies for demineralization. The RO plant is designed to remove 90% of all salts while achieving a minimum of 85% product water recovery.

Table 62 shows RO plant costs per unit of water produced. No costs are included for brine disposal since at OCWD the brine is simply discharged to the sanitary sewer. Most maintenance is performed by Fluid Systems Division, UOP, Inc., under a five-year maintenance contract which provides for all cartridge filter replacement, membrane replacement, and routine preventive and emergency maintenance.

The annual maintenance contract, which guarantees a specified level of performance, costs OCWD about $260,000/yr; however, penalties provided for in the contract when performance is not achieved reduced this amount to $229,000 in the cost year. The actual amount paid was used in calculating the unit costs. There would perhaps be slightly higher unit costs if no penalties were invoked; but the difference would be small because more water would have been produced, thereby more than offsetting the higher maintenance contract payments. Penalties were assessed due to the plant's failure to produce the specified quantity of water and because energy consumption exceeded guarantees.

TABLE 62. WATER FACTORY 21 OPERATING AND CAPITAL COSTS
REVERSE OSMOSIS DEMINERALIZATION

	$\$/10^3m^3$	
Capital		63.59
Operating		208.51
Operations labor	18.37	
Maintenance labor	3.91	
Electricity	115.81	
H_2SO_4	8.16	
Cl_2	0.39	
SHMP	8.26	
Maint. contract	53.48	
Gas	0.13	
TOTAL		272.10

Deep Well System

The reclaimed and demineralized wastewater are blended with deep well water prior to injection. There are four individual deep wells which can be pumped to provide blending water. Three of the wells are located north of the WF21 site, and all are interconnected by a 0.6 m diameter pipeline. Each of these wells is about 300 m deep with the area of perforations occurring below 170 m. Each well is equipped with a 200-hp motor and capable of producing up to 13 m^3/min. The fourth deep well is on site and extends into the same zone, but is equipped with only a 60-hp motor and pumps about 4.5 m^3/min. All water produced by these wells is pumped into a blending reservoir before being injected with the reclaimed water produced by WF21. Table 63 shows the deep well blending-water costs, which include the replenishment assessment of 2.4¢/m^3 for this period. This represents the cost OCWD must pay for use of groundwater. Maintenance costs include various pump repairs and adjustments as well as routine preventive maintenance.

TABLE 63. WATER FACTORY 21 OPERATING AND CAPITAL COSTS
DEEP-WELL BLENDING SYSTEM

	$\$/10^3 m^3$	
Capital		16.27
Operating		44.49
Operating labor	2.35	
Maintenance labor	1.51	
Electricity	14.34	
Maint. materials	0.86	
Replen. Assessment	25.43	
TOTAL		60.76

Injection System

The final AWT chlorinated effluent, the RO plant product water, and the deep well water are blended in a reservoir constructed of prestressed concrete, with a capacity of approximately 3,785 m^3 (1 MG). The blended effluent is pumped by gas-driven pumps to 23 multiple casing injection wells located along a six km reach of the Talbert Gap. Injection maintenance costs, including well redevelopment and injection pump repairs, are shown in Table 64. The gas engines used to power the injection pumps were replaced this year with variable frequency electric motors, and this has diminished the maintenance requirements for these pumps.

TABLE 64. WATER FACTORY 21 OPERATING AND CAPITAL COSTS
INJECTION SYSTEM

	$\$/10^3 m^3$	
Capital		17.02
Operating		9.01
Operations labor	1.09	
Maintenance labor	3.13	
Gas	1.96	
Maint. materials	0.67	
Chlorine	2.16	
TOTAL		26.03

SUMMARY AND CONCLUSIONS

A summary of the captial and actual operating costs for fiscal year 1980-81 for each unit process within the AWT plant at WF21 is provided in Table 65. AWT captial cost is $\$169/10^3 \text{ m}^3$ and AWT operating and maintenance cost is $\$243/10^3 \text{ m}^3$. RO capital cost is $\$64/10^3 \text{ m}^3$, and O & M cost is $\$208/10^3 \text{ m}^3$. The capital cost of the deep-well water-blending system is $\$16/10^3 \text{m}^3$ and the operating cost is $\$45/10 \text{ m}^3$. The cost of injecting the waters produced by the AWT, RO and deep-well facilities is $\$16/10^3 \text{ m}^3$ capital and $\$9/10^3 \text{ m}^3$ O & M. When AWT, RO and deep-well costs are combined and injection costs added, the cost of the blended water injected is $\$156/10^3 \text{ m}^3$ capital and $\$272/10^3 \text{ m}^3$ O & M for a total cost of $\$428/10^3 \text{ m}^3$.

How does this blended water cost compare with the cost of other water supplies available in Southern California? OCWD, in a previous report (13), compared the cost of wastewater reclamation with the cost of imported waters being furnished Southern California through the Colorado River Aqueduct and the State Water Project. The cost of the conventional water supplies was adjusted to reflect the actual cost of providing this water to the community. It was shown that when tax and other subsidies such as power rates were removed, the cost of imported water would exceed the cost of wastewater reclamation. More recently, estimates have been made for furnishing additional water supplies to Southern California through even longer, more energy intensive aqueducts from sources as far away as the Columbia River. Preliminary estimates for these water supplies range from $\$400/10^3 \text{ m}^3$ to $\$800/10^3 \text{ m}^3$. Thus, even during a period when the plant was operated at reduced flow rates, the cost of reclamation was still lower than other alternatives.

TABLE 65. WATER FACTORY 21 OPERATING AND CAPITAL COSTS SUMMARY

Process	$\$/10^3\text{m}^3$		
	Capital	O & M	Total
Influent pump and lime clarifier	18	44	62
Solids handling	28	91	119
Ammonia stripping	48	11	59
Recarbonation	7	23	30
Filtration	15	8	23
Activated-Carbon Adsorption	37	19	56
Activated-Carbon Regeneration	13	32	45
Chlorination	3	15	18
AWT Subtotal	169	243	412
RO demineralization	64	208	272
Deep well water	16	45	61
Injection	17	9	26
BLENDED WATER COST	156	272	428

It is important to keep in mind when comparing cost per unit volume that actual costs incurred during the 1980-81 cost year were pushed considerably higher because of the decision to operate the WF21 well below its design capability. This caused the average unit cost to be greater because several cost increments are fixed and do not decrease as production is reduced. This is the case for the captial portion as well as some O & M costs. Since no staff reductions were made, labor costs are fixed. The power costs are not proportional, as flow reductions often cause the pumps to operate less efficiently. Even maintenance repairs do not decrease directly with flow.

To provide a more realistic cost estimate for producing reclaimed water at WF21 if the plant were operated under design-flow conditions, the actual costs incurred during fiscal year 1980-81 were projected to reflect operation at design flow. The following basic assumptions were made to develop these projections.

(1) The AWT process treated 0.66 m^3/s with a 90% plant availability factor (PAF), which equals the percentage of time during the year plant is operated.

(2) The RO plant received 0.26 m^3/s of AWT water for demineralization and produced 0.22 m^3/s with 90% PAF.

(3) Therefore, the AWT plant produced 0.4 m^3/s with 90% PAF.

(4) 0.26 m^3/s of deep-well water was extracted to blend with 0.22 m^3/s RO and 0.4 m^3/s AWT water to give a total injection of 0.88 m^3/s.

(5) All energy and chemical requirements were projected on the basis of actual quantities required to treat expanded flows.

(6) Labor and maintenance costs were based on actual expenses incurred during fiscal year 1980-81.

The projected unit cost of operating WF21 is given in Table 66. This shows that the cost of producing reclaimed water only for injection would be $\$85/10^3\ m^3$ for captial and $\$218/10^3\ m^3$ for O & M, for a total cost of $\$303/10^3\ m^3$.

Energy

Much of the water to meet the needs of Orange County has been provided historically by large-scale importation of water from distant sources, primarily the State Water Project, which brings northern California water from the Sacramento Delta down to Southern California, and the Colorado River Aqueduct. At the time of their inception, development of these projects was well within reasonable dollar and energy economic limits. However, energy requirements will play a key role in determining the course of future water-supply projects.

As is the case with any water supply, energy is required to deliver the water to its point of use. Studies made by OCWD (14) have indicated that when wastewater reclamation projects are evaluated on an energy cost basis, they show even greater potential savings than when compared strictly on a dollar and cents basis. Since local water supplies are inadequate to meet the demands of Orange County, California, this particular area of the country will continue to experience a very high energy cost for water. Current estimates for delivering Northern California water through the State Water Project to the Southern California area indicate an energy cost of approximately 2600 kWh per 10^3 m^3. The energy cost of furnishing Colorado River water to Southern California is 1700 kWh per 10^3 m^3.

Table 67 gives the primary energy requirements for wastewater reclamation at WF21. This table shows the actual amount of energy used during the 1980-81 fiscal year to produce reclaimed water, which was then injected back into the groundwater supply. When looking at the total energy cost of producing this reclaimed water and comparing it to the energy cost of supplying Northern California water, one can see that even when demineralization is included, the energy cost of reclamation is less than the energy cost associated with pumping Northern California water to Southern California. The Orange County and Los Angeles Counties Water Reuse Study (15) has shown that for reuse applications where water quality requirements are less stringent than those imposed for groundwater recharge and injection at WF21, even greater energy savings can be realized. Therefore, it would appear that wastewater reclamation will play a key role in meeting the future water needs of Southern California.

With energy playing an increasingly important role in the economics of water supply, it is apparent that in many applications the least energy intensive alternative will be reuse. It is therefore imperative that research on removing substances of health concern, such as organics and viruses, be expedited to provide the data necessary to address the questions being raised by regulatory officials regarding wastewater reuse for domestic purposes.

TABLE 66. WATER FACTORY 21 PROJECTED CAPITAL/O&M COSTS FISCAL YEAR 1980-81 AT DESIGN FLOW RATE ($/$10^3 m^3$) ASSUMES 0.66 m^3/s AT 90% PLANT AVAILABILITY FACTOR

Treatment Process	Annual Flow $10^6 m^3$	Captial Cost Amortized 20 yrs @ 7%	Labor		Utilities		Chemicals						Maint. Matls.	Replen. Assess.	Total O&M	Total Capital and O&M
			Oper.	Maint.	Gas	Elec.	Carbon	SHMP	Lime	Polymer	Chlorine	Acid				
Influent pumping/ Lime clarif.	18.7	6.05	4.38	2.24		3.89			15.52	0.58			1.60		28.22	34.27
Air stripping	18.7	15.64	0.58	0.37		28.93							0.21		30.11	45.74
Recarbonation	18.7	2.13	1.75	1.50		2.91					1.92	2.75	1.15		11.98	14.11
Filtration	18.7	4.78	1.75	0.37		0.50							0.26		2.88	7.66
Act. Carbon Ads.	18.7	11.84	1.75	0.93		5.83							0.71		9.23	21.07
Act. Carbon Regen.	18.7	4.39	2.91	2.80	2.52	1.32	3.77						1.87		15.21	19.60
Chlorination	11.2	1.96	2.92	2.49		1.02					6.00		1.43		13.87	15.82
Solids Handling	18.7	9.34	8.76	7.11	8.78	3.91							5.57		34.13	43.47
AWT SUBTOTAL	18.7	55.34	23.65	16.83	11.30	47.92	3.77		15.52	0.58	5.52	2.75	12.25		140.07	195.41
Reverse Osmosis only	6.2	45.50	13.14	2.80	0.13	104.07		8.26			0.37	8.16	38.27		175.20	220.70
Deep Well Blending	7.5	10.11	1.46	0.94		12.36							0.54	16.20	31.49	41.60
Injection	24.9	6.82	0.44	1.26		1.84							0.27		3.80	10.62
TOTAL COST Blended Water*	24.9	62.74	21.90	14.86	8.51	67.49	2.83	2.07	11.64	0.44	4.23	4.11	19.18	4.88	162.14	224.88
TOTAL COST Reclaimed Water only#	17.4	85.30	30.65	20.82	12.16	91.12	4.04	2.95	16.63	0.62	6.04	5.87	27.17		218.03	303.33

* Blended Water Cost = [18.7 (AWT subtotal) + 6.2 (RO only) + 7.5 (Deep Well Blend) + 24.9 (Injection)]/24.9

# Reclamied Water Cost = [18.7 (AWT subtotal) + 6.2 (RO only) + 17.4 (Injection)] /17.4

TABLE 67. WATER FACTORY 21 ENERGY REQUIREMENTS FOR WASTEWATER RECLAMATION

Process	kWh/yr	kWh/10^3m^3
Influent pumping/lime clarification	552,982	90
Solids handling/lime recalcination*	3,943,761	644
Air stripping	783,344	128
Recarbonation	412,741	67
Filtration	82,017	13
Activated carbon adsorption	952,500	156
Activated carbon regeneration	601,156	98
Chlorination	157,413	26
AWT Subtotal	7,485,914	1,222
RO demineralization	8,907,290	2,000
Deep wells	969,927	209
Injection	337,345	34
Blended Water - Total	17,700,476	1,773

*Includes energy costs for natural gas, assuming 1 kWh = 10,500 BTU.

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APPENDIX A

MAJOR DESIGN CRITERIA FOR 0.66 m^3/s ADVANCED WASTEWATER TREATMENT PLANT

INFLUENT PUMP STATION

Number of pumps: 2
Capacity: 0.41 m^3/s @ 8.8 m TDH, 0.44 m^3/s @ 8.2 m TDH
Type: Vertical mixed flow

CHEMICAL CLARIFICATION SYSTEM

Rapid Mixing

Number of Basins: 2 in series; mechanical mixer in each basin
Dimension: Length, 3.7 m; width, 3.7 m; depth, 3.7 m
Detention time: 2.4 minutes total @ 0.66 m^3/s
Chemical addition: First basin, lime alum, recylced lime sludge; second basins, polymer

Flocculation

Number of basins: 2, three compartments each
Detention time: 10 min/compartment (30 min total) @ 0.66 m^3/s
Chemical addition: Polymer, 1st and 3rd compartment
Dimensions: Length, 15 m; width, 12.5 m; depth, 3.4 m
Flocculator mechanism: Oscillating type

Settling Basin

Number of basins: 2 rectangular
Dimensions: 37 m long x 12 m wide, each
Surface overflow rate: 2.7 m^3/m^2-hr @ 0.66 m^3/s
Each basin equipped with settling tubes

Clarifier Effluent Pump Station

Number of pumps: 4
Capacity: 0.21 m^3/s @ 23 m; 0.22 m^3/s @ 20 m
Discharge: To air stripping tower or to the OCSD plant or to the recarbonation basins

Lime Feeders and Slakers

Number: 2 gravimetric feeders and paste-type slakers
Capacity: 0.5 kg/s

Polymer Feed System

Number of mixing tanks: 2 (4 m^3 each)
Number of feed pumps: 4 dual head
Capacity: 0 to 0.1 m^3/h each head

Alum Feed System

Number of storage tanks: 2 (18 m^3 each)
Number of feed pumps: 3 (2 double head and 1 single head)
Capacity: 0.1 m^3/h each head

AIR STRIPPING/COOLING TOWERS

Number of towers: 2
Dimensions: Length, 63 m; width, 19 m; depth of packing, 7.6 m
Capacity: 0.33 m^3/s each @ 0.44 m^3/m^2-min
Number of fans: 6 per tower, 5.5 m diameter, 2-speed electric motors
Air capacity: 990 m^3/s per tower (3000 m^3/m^3)
Net water streams: Tower No. 1, 0.50 m^3/s cool $46^{o}C$ to $26^{o}C$
Tower No. 2, 0.69 m^3/s cool $50^{o}C$ to 30 ^{o}C

RECARBONATION

Number: Two 3-compartment basins, originally designed for two-stage recarbonation but always used as one-stage recarbonation basin
Detention time: 30 minutes (15 min. each basin)
Overflow rate: intermediate settling, 5 m^3/m^2- h @ 0.66 m^3/s

FILTRATION

Number of filters: 4
Dimensions: 6.7 m x 7.3 m
Type: Open, gravity, mixed media
Mixed media: Anthracite, 42 cm; silica sand, 23 cm; garnet sand, 11 cm; graded garnet gravel, 8 cm; silica gravel, 15 cm
Hydraulic loading rate: 0.2 m^3/m^2-min @ 0.66 m^3/s
Maximum operating head loss: 3 m
Backwash system: Hydraulic with rotating surface wash arms. Backwash rate, 0.6 m^3/m^2-min; surface wash rate, 0.024 m^3/m^2-min
Backwash water receiving tank volume: 705 m^3

ACTIVATED-CARBON ADSORPTION

Number of contactors 17
Normal service: 16 in parallel operation, 1 for carbon storage and standby service
Type: Countercurrent, in steel pressure vessels, upflow during first and second periods, but downflow during third period
Dimensions: Overall height, 12.5 m; sidewall height, 7.3 m; diameter 3.7 m
Contact time: 34 minutes at 0.66 m^3/s
Carbon size: 8 x 30 mesh (Filtrasorb 300, bulk density - 420 kg/m^3)
Carbon weight: 35 Mg per contactor (660 Mg total)

CHLORINATION

Number of contact basins: 1
In-line feeding and mixing contact time: 30 minutes
Chlorine feeders: 3 (900 kg/day each)
On-site generation of chlorine: 900 kg/day

CHEMICAL SLUDGE TREATMENT AND RECOVERY SYSTEMS

Sludge Pumps

Number: 3
Capacity: 0.032 to 0.44 m^3/s
Influent solids cpability: 5% maximum

Sludge Thickener

Number: 1
Dimensions: 14 m diameter, 2.5 m sidewater depth
Loading: 24 m^3/m^2-d @ 1.5% solids from clarifier at flow of 0.66 m^3/s; dry solids loading = 15 kg/m^3-h
Thickened sludge concentration: 8 to 15% solids

Thickened Sludge Pumps

Number: 3
Capacity: 5 liter/m at 18 m head each, variable speed
Influent solids capability: 18 % maximum

Centrifuges

Number: 2
Capacity: 900 kg/hour each
Feed rate: 3 to 6.6 liters/m

Recalcining Furnace

- Number: 1, 6 hearth
- Dimensions: 6.8 m OD; 6.1 m ID
- Capacity: 0.1 to 0.5 kg/s dry CaO
- Scrubber: 3-stage jet impingement
- Fuel: Natural gas with propane standby

Lime Storage Bins

- Number: 2
- Capacity: 32 Mg each
- Dimensions: 3.8 m diameter by 4.6 m storage depth (overall height = 8.7 m)

Carbon Dioxide Compressors

- Number: 3
- Capacity: 0.76 m^3/s (12% CO_2) each

ACTIVATED CARBON REGENERATION

Regeneration Furnace

- Number of furnaces: 1, 6 hearth
- Dimensions: 2.8 m OD; 2.1 m ID
- Capacity: 0.01 to 0.063 kg/s (dry basis)
- Steam addition: No. 4 and No. 6 hearths (optional); 1 kg steam per kg carbon
- Air pollution control:
  - Fuel: Natural gas with propane standby
  - Scrubber: Venturi followed by water separator
  - Afterburner: Vertical, refractory lined steel, 760°C at 0.5 seconds minimum gas retention time

Carbon Wash and Transfer Tanks

- Number: 2
- Dimensions: 1.5 m diameter by 3 m high
- Equipped with bag dump and dust collector

Regenerated Carbon Wash Tanks

- Number: 2
- Dimensions: 1.5 m diameter by 3 m high

Spent Carbon Dewatering Tanks

- Number: 2 (open top)
- Dimensions: 1.5 m x 1.5 m x 4.4 m high
- Furnace feed system: 0.3 m diameter screw conveyer, stainless steel with capacity of 0.01 to 0.063 kg/s on a dry basis

Carbon Slurry Pumps (transfer carbon from regeneration furnace to carbon wash tanks)

Number: 2
Type: Diaphragm slurry, air operated, 7.6 cm suction and discharge
Capacity: 0.03 m^3/s max. with 4:1 turndown ratio

APPENDIX B

MAJOR DESIGN CRITERIA FOR 0.22 m^3/s REVERSE-OSMOSIS PLANT

GENERAL PERFORMANCE REQUIREMENTS

Minimum permeater flow rate: 0.22 m^3/s
Maximum concentrate flow rate: 0.04 m^3/s
Feed flow rate: 0.26 m^3/s
Design feed water temperture: 18°C
Annual throughput requirement: 6.4×10^6 m^3
Minimum permeate water recovery: 85%
Minimum salt rejection: 90%
Concentrate pH: 5.0 to 8.0
Permeate pH: 6.5 to 8.0
Maximum noise level outside RO building: 55 db_a

PRE-TREATMENT

Feed Water Source

Normal: Activated-carbon adsorption effluent
Optional: Mixed-media filtration effluent

Filter Feed Pumps

Type: Vertical turbine, single stage
Number: 3 (includes 1 standby)
Capacity: 0.13 m^3/s
TDH: 18 m
Power: 37 kW each

Scale-Inhibitor Feeder

Number: 1
Design rate: 1.9 kg/hr (2 mg/l)
Maximum capacity: 10 kg/hr (10.5 mg/l)
Inhibitor: sodium hexametaphosphate

Chlorinators

Number: 1
Capacity: 230 kg/d (10.2 mg/1)
Note: Backup to this unit from Water Factory 21 chlorinators

Feed Clearwell

Number: 1
Total capacity: 57 m^3
Average detention time at 0.26 m^3/s: 3.67 min

RO Flow Rates

Feed flow: Per section, 0.043 m^3/s; per unit, 0.13 m^3/s; total plant, 0.26 m^3/s
Permeate flow: Per section, 0.037 m^3/s; per unit, 0.11 m^3/s; total plant, 0.22 m^3/s
Concentrate flow: Per section, 0.0064 m^3/s; per unit, 0.019 m^3/s; total plant, 0.039 m^3/s

POST-TREATMENT

Decarbonators

Number: 2 (both normally in operation)
Type: Countercurrent packed bed
Tower packing: Polethylene dumped packing, 2.6 m x 2.6 m x 2.4 m high
Air flow rate: 22 m^3/m^2
Hydraulic loading: 25 m/min

Permeate Clearwell

Number: 1
Total capacity: 34 m^3
Average detention time at 0.22 m^3/s: 2.55 min

Permeate Pumps

Type: Vertical turbine, single stage
Number: 3 (includes 1 standby)
Capacity: 0.11 m^3/s
TDH: 7.6 m
Power: 15 kW each

ELECTRICAL ENERGY REQUIREMENTS

Voltage	Total Installed (kW)
2300	2000
480	250
Total	2250

Cartridge Filters

Number:	4 (includes 1 standby)
Elements:	240 250-mm or 120 500-mm polypropylene cartridges per filter
Rating:	25 μm

RO Feed Pumps Clearwell

Number:	1
Total Capacity	128 m^3

Average detention time at 0.26 m^3/s: 825 min

RO Feed Pumps

Type:	Vertical turbine, 17 stages
Number:	3 (includes 1 standby)
Capacity:	0.13 m^3/s
TDH:	420 m, maximum; 280 m, normal
Power:	670 kW each

Acid Feeders

Acid:	Concentrated sulfuric acid (93% or 66°Be')
pH:	RO feed adjusted to pH 5.5
Type:	Positive displacement
Number:	3 (includes 1 standby)
Capacity:	0.66 liters/min each, design; 1.3 liters/min each, maximum

REVERSE OSMOSIS

Number of units:	2 (both normally in operation)
Number of sections:	3 per unit
Number of pressure vessels:	42 per section
Number of membranes:	6 per pressure vessel
Total number of:	Units, 2; sections, 6; pressure vessels, 252; membranes, 1512
Pressure vessel array per section:	24 - 12 - 6
Pressure vessel length:	6.7 m
Nominal pressure vessel diameter:	200 mm
Membrane diameter:	200 mm
Membrane length:	1 m
Membrane type:	Spiral wound, cellulose acetate

APPENDIX C

SUMMARY DATA FOR PERIOD MARCH 1978 TO APRIL 1981

Location Designation	Description
001	Q1 - Plant influent
002	Q2 - Chemical effluent
003	Q3 - Between air stripping towers
004	Q4 - Stripping tower effluent
005	Q5 - Midpoint between two recarbonation chambers
006	Q6 - Recarbonation basin effuent
007X	Q7X - Effluents from individual GAC columns
008	Q8 - GAC effluent - influent to final chlorination basin
009	Q9 - Final chlorination effluent
010	Q10 - Combined effluents for injection
21A	Q21A - Influent to experimental RO plant - special study
21B	Q21B - Effluent from experimental RO plant - special study
22A	Q22A - GAC effluent - influent to RO
22B	Q22B - RO effluent - after decarbonation
22C	Q22C - RO effluent - prior to decarbonation

WATER FACTORY 21
SUMMARY DATA FOR GENERAL PARAMETERS FILE 1
FOR PERIOD FROM 1MAR78 TO 1APR81
(CONCENTRATIONS FOR CYANIDE AND PHENOL IN UG/L, ALL OTHERS IN MG/L)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	TOTAL DISS.SOLIDS	154	154	110.00 -1290.00	942.25	1.19	916.57 - 968.64
001	TOTAL HARDNESS	122	122	99.00 - 400.00	292.48	1.13	286.23 - 298.87
001	MAGNESIUM	156	156	7.40 - 78.00	23.42	1.31	22.45 - 24.44
001	SODIUM	123	123	7.40 - 460.00	178.06	1.29	170.22 - 186.26
001	POTASSIUM	26	26	8.40 - 58.00	14.27	1.34	12.68 - 16.05
001	BORON	156	156	0.40 - 1.60	0.79	1.22	0.77 - 0.82
001	PHOSPHATE	152	152	0.20 - 10.00	5.37	1.25	5.18 - 5.56
001	CYANIDE	144	144	2.90 - 220.00	24.67	1.99	22.06 - 27.60
001	METH. BLUE ACTIVE SUBS	116	116	0.03 - 0.76	0.22	1.60	0.20 - 0.24
001	PHENOL	121	121	1.00 - 22.00	7.55	1.80	6.80 - 8.39
001	AMMONIA NITROGEN	355	274	< 0.10 - 67.76	2.79	6.45	2.24 - 3.48
001	ORGANIC NITROGEN	161	152	< 0.10 - 7.40	1.95	1.53	1.82 - 2.09
001	TOT KJELDAHL NITROGEN	161	161	1.50 - 62.00	11.32	2.33	9.93 - 12.90
001	NITRATE NITROGEN	190	168	< 0.10 - 34.00	1.69	7.18	1.26 - 2.28
001	FREE CHLORINE RESIDUAL	0	0	< 0.10	< 0.10	?	?
001	TOTAL CHLORINE RESID.	0	0	< 0.10	< 0.10	?	?
002	TOTAL DISS.SOLIDS	56	56	810.00 -1370.00	1005.80	1.12	977.19 -1035.25
002	TOTAL HARDNESS	24	24	180.00 - 510.00	240.03	1.29	215.70 - 267.10
002	MAGNESIUM	58	54	< 0.10 - 20.00	1.78	3.75	1.25 - 2.53
002	SODIUM	25	25	200.00 - 270.00	230.63	1.09	222.31 - 239.27
002	POTASSIUM	25	25	8.50 - 58.00	14.42	1.33	12.83 - 16.20
002	BORON	58	58	0.50 - 0.90	0.63	1.19	0.60 - 0.65
002	PHOSPHATE	148	98	< 0.10 - 3.40	0.07	4.64	0.06 - 0.10
002	CYANIDE	47	47	8.80 - 92.00	29.17	1.76	24.81 - 34.28
002	METH. BLUE ACTIVE SUBS	112	112	0.04 - 0.62	0.19	1.74	0.17 - 0.21
002	PHENOL	105	105	1.00 - 82.00	8.55	1.91	7.56 - 9.67
002	AMMONIA NITROGEN	361	331	< 0.10 - 68.00	3.75	5.50	3.12 - 4.50
002	ORGANIC NITROGEN	161	152	< 0.10 - 6.30	0.97	1.67	0.89 - 1.05
002	TOT KJELDAHL NITROGEN	161	161	2.10 - 70.00	11.60	2.18	10.29 - 13.09
002	NITRATE NITROGEN	24	12	< 0.10 - 1.00	0.07	3.72	0.03 - 0.16
002	FREE CHLORINE RESIDUAL	0	0	< 0.10	< 0.10	?	?
002	TOTAL CHLORINE RESID.	0	0	< 0.10	< 0.10	?	?
003	TOTAL DISS.SOLIDS	0	0	< 1.00	< 1.00	?	?
003	TOTAL HARDNESS	0	0	< 1.00	< 1.00	?	?
003	MAGNESIUM	0	0	< 0.10	< 0.10	?	?
003	SODIUM	0	0	< 0.10	< 0.10	?	?
003	POTASSIUM	0	0	< 0.10	< 0.10	?	?
003	BORON	0	0	< 0.10	< 0.10	?	?
003	PHOSPHATE	0	0	< 0.10	< 0.10	?	?
003	CYANIDE	0	0	< 0.10	< 0.10	?	?
003	METH. BLUE ACTIVE SUBS	0	0	< 0.10	< 0.10	?	?
003	PHENOL	0	0	< 1.00	< 1.00	?	?
003	AMMONIA NITROGEN	156	142	< 0.10 - 67.20	1.61	5.45	1.22 - 2.13
003	ORGANIC NITROGEN	21	21	0.80 - 2.80	1.28	1.42	1.09 - 1.49

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                                         WATER FACTORY 21
                              SUMMARY DATA FOR GENERAL PARAMETERS FILE 1
                                 FOR PERIOD FROM   1MAR78 TO 1APR81
                    (CONCENTRATIONS FOR CYANIDE AND PHENOL IN UG/L, ALL OTHERS IN MG/L)


                                                        NUMBER OF DATA
LOCATION       CHEMICAL          NUMBER OF DATA  ABOVE DETECTION LIMIT  RANGE OF DATA   GEOMETRIC MEAN  SPREAD FACTOR   95% CI
--------       --------          --------------  ---------------------  -------------   --------------  -------------   ------
  003    TOT KJELDAHL NITROGEN         21                 21            3.10 -  35.00        9.72           2.00     7.09 -  13.31
  003    NITRATE NITROGEN               0                  0              <  0.10         <  0.10             ?              ?
  003    FREE CHLORINE RESIDUAL         0                  0              <  0.10         <  0.10             ?              ?
  003    TOTAL CHLORINE RESID.          0                  0              <  0.10         <  0.10             ?              ?

  004    TOTAL DISS.SOLIDS             24                 24          854.00 -1624.00     1014.80           1.16   953.81 -1079.69
  004    TOTAL HARDNESS                24                 24          104.00 - 540.00      219.73           1.41   190.06 - 254.02
  004    MAGNESIUM                     24                 22         <  0.10 -   8.80        1.15           4.96     0.57 -   2.33
  004    SODIUM                        24                 24          150.00 - 260.00      223.93           1.10   214.86 - 233.38
  004    POTASSIUM                     24                 24            8.50 -  58.00       14.37           1.34    12.70 -  16.26
  004    BORON                         24                 24            0.50 -   1.00        0.67           1.21     0.62 -   0.72
  004    PHOSPHATE                     24                  1              <  0.10         <  0.10             ?              ?
  004    CYANIDE                       23                 23            0.45 -  77.00       27.68           2.58    18.40 -  41.65
  004    METH. BLUE ACTIVE SUBS        23                 23            0.10 -   0.80        0.28           1.65     0.23 -   0.35
  004    PHENOL                        25                 25            2.40 -  25.00        6.64           1.67     5.37 -   8.20
  004    AMMONIA NITROGEN             219                201         <  0.10 -  66.00        3.90           5.26     3.10 -   4.91
  004    ORGANIC NITROGEN              85                 76         <  0.10 -   6.00        0.91           1.79     0.80 -   1.04
  004    TOT KJELDAHL NITROGEN         86                 86            0.80 -  67.00       12.72           2.28    10.69 -  15.14
  004    NITRATE NITROGEN              21                 21            0.20 -   1.60        0.58           1.75     0.45 -   0.74
  004    FREE CHLORINE RESIDUAL         0                  0              <  0.10         <  0.10             ?              ?
  004    TOTAL CHLORINE RESID.          0                  0              <  0.10         <  0.10             ?              ?

  005    TOTAL DISS.SOLIDS              0                  0              <  1.00         <  1.00             ?              ?
  005    TOTAL HARDNESS                 0                  0              <  1.00         <  1.00             ?              ?
  005    MAGNESIUM                      0                  0              <  0.10         <  0.10             ?              ?
  005    SODIUM                         0                  0              <  0.10         <  0.10             ?              ?
  005    POTASSIUM                      0                  0              <  0.10         <  0.10             ?              ?
  005    BORON                          0                  0              <  0.10         <  0.10             ?              ?
  005    PHOSPHATE                      0                  0              <  0.10         <  0.10             ?              ?
  005    CYANIDE                        0                  0              <  0.10         <  0.10             ?              ?
  005    METH. BLUE ACTIVE SUBS         0                  0              <  0.10         <  0.10             ?              ?
  005    PHENOL                         0                  0              <  1.00         <  1.00             ?              ?
  005    AMMONIA NITROGEN             150                101         <  0.10 -  26.18        0.62           6.81     0.43 -   0.91
  005    ORGANIC NITROGEN               0                  0              <  0.10         <  0.10             ?              ?
  005    TOT KJELDAHL NITROGEN          0                  0              <  0.10         <  0.10             ?              ?
  005    NITRATE NITROGEN               0                  0              <  0.10         <  0.10             ?              ?
  005    FREE CHLORINE RESIDUAL         0                  0              <  0.10         <  0.10             ?              ?
  005    TOTAL CHLORINE RESID.          0                  0              <  0.10         <  0.10             ?              ?

  006    TOTAL DISS.SOLIDS             26                 26          838.00 -1250.00      997.51           1.13   950.88 -1046.44
  006    TOTAL HARDNESS                25                 25          170.00 - 300.00      224.98           1.23   206.44 - 245.18
  006    MAGNESIUM                     26                 25         <  0.10 -   7.60        2.14           2.62     1.44 -   3.18
  006    SODIUM                        26                 26          190.00 - 260.00      224.79           1.08   217.73 - 232.07
  006    POTASSIUM                     26                 26            8.50 -  56.00       14.08           1.34    12.51 -  15.85
  006    BORON                         26                 26            0.40 -   0.80        0.63           1.18     0.59 -   0.68
  006    PHOSPHATE                     26                  1              <  0.10         <  0.10             ?              ?
  006    CYANIDE                       25                 25            0.40 - 170.00       34.31           3.52    20.44 -  57.60
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WATER FACTORY 21
SUMMARY DATA FOR GENERAL PARAMETERS FILE 1
FOR PERIOD FROM 1MAR78 TO 1APR81
(CONCENTRATIONS FOR CYANIDE AND PHENOL IN UG/L, ALL OTHERS IN MG/L)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
006	METH. BLUE ACTIVE SUBS	24	23	< 0.10 - 0.47	0.21	1.59	0.17 - 0.26
006	PHENOL	102	102	1.00 - 29.00	6.58	1.04	5.85 - 7.40
006	AMMONIA NITROGEN	48	48	13.00 - 67.00	25.27	1.28	23.57 - 27.09
006	ORGANIC NITROGEN	45	35	< 0.10 - 6.00	1.16	1.92	0.94 - 1.44
006	TOT KJELDAHL NITROGEN	45	45	14.00 - 70.00	26.59	1.29	24.67 - 28.65
006	NITRATE NITROGEN	25	25	0.20 - 3.60	0.66	1.85	0.52 - 0.86
006	FREE CHLORINE RESIDUAL	147	51	< 0.10 - 4.52	0.04	6.07	0.02 - 0.06
006	TOTAL CHLORINE RESID.	340	338	< 0.10 - 18.00	3.01	1.97	2.80 - 3.24
008	TOTAL DISS.SOLIDS	21	21	852.00 -1260.00	990.24	1.12	940.56 -1042.54
008	TOTAL HARDNESS	19	19	170.00 - 300.00	221.42	1.21	202.09 - 242.61
008	MAGNESIUM	22	21	< 0.10 - 7.40	2.46	2.24	1.70 - 3.55
008	SODIUM	22	22	200.00 - 260.00	229.49	1.07	222.63 - 236.56
008	POTASSIUM	1	1	?	?	?	?
008	BORON	22	22	0.30 - 0.80	0.58	1.33	0.51 - 0.66
008	PHOSPHATE	1	1	?	?	?	?
008	CYANIDE	17	16	< 0.10 - 52.00	20.57	2.03	14.15 - 29.89
008	METH. BLUE ACTIVE SUBS	101	62	< 0.10 - 0.18	0.04	2.27	0.04 - 0.05
008	PHENOL	97	73	< 1.00 - 8.70	1.29	2.78	1.02 - 1.63
008	AMMONIA NITROGEN	42	42	15.00 - 64.00	24.48	1.25	22.85 - 26.22
008	ORGANIC NITROGEN	36	22	< 0.10 - 2.70	0.38	2.72	0.24 - 0.58
008	TOT KJELDAHL NITROGEN	36	36	15.00 - 65.00	25.07	1.27	23.17 - 27.13
008	NITRATE NITROGEN	40	40	0.10 - 3.90	0.53	2.50	0.40 - 0.70
008	FREE CHLORINE RESIDUAL	0	0	< 0.10	< 0.10	?	?
008	TOTAL CHLORINE RESID.	0	0	< 0.10	< 0.10	?	?
009	TOTAL DISS.SOLIDS	103	103	524.00 -1270.00	921.68	1.16	895.97 - 948.14
009	TOTAL HARDNESS	103	103	180.00 - 410.00	232.94	1.17	226.06 - 240.02
009	MAGNESIUM	108	108	0.40 - 92.00	4.29	2.46	3.62 - 5.08
009	SODIUM	104	104	110.00 - 280.00	193.84	1.22	186.65 - 201.30
009	POTASSIUM	48	48	8.40 - 56.00	13.62	1.24	12.81 - 14.47
009	BORON	104	104	0.20 - 1.00	0.59	1.24	0.56 - 0.61
009	PHOSPHATE	1	1	?	?	?	?
009	CYANIDE	97	93	< 0.10 - 260.00	9.45	3.38	7.38 - 12.10
009	METH. BLUE ACTIVE SUBS	93	52	< 0.10 - 0.50	0.04	3.31	0.03 - 0.05
009	PHENOL	4	4	1.00 - 1.00	1.00	?	?
009	AMMONIA NITROGEN	211	142	< 0.10 - 41.00	0.94	9.51	0.65 - 1.36
009	ORGANIC NITROGEN	113	103	< 0.10 - 3.10	0.86	1.93	0.76 - 0.98
009	TOT KJELDAHL NITROGEN	113	113	0.40 - 41.00	5.54	2.97	4.53 - 6.77
009	NITRATE NITROGEN	105	105	0.12 - 30.00	4.32	3.30	3.44 - 5.43
009	FREE CHLORINE RESIDUAL	196	155	< 0.10 - 18.04	1.53	4.69	1.20 - 1.95
009	TOTAL CHLORINE RESID.	368	368	0.10 - 67.00	12.97	2.36	11.88 - 14.16
010	TOTAL DISS.SOLIDS	152	152	68.00 - 888.00	289.59	1.71	266.04 - 315.23
010	TOTAL HARDNESS	154	154	8.00 - 492.00	54.07	2.21	47.70 - 61.28
010	MAGNESIUM	154	153	< 0.10 - 8.40	0.99	3.00	0.83 - 1.18
010	SODIUM	155	155	16.00 - 240.00	71.81	1.54	67.06 - 76.89

WATER FACTORY 21
SUMMARY DATA FOR GENERAL PARAMETERS FILE 1
FOR PERIOD FROM 1MAR78 TO 1APR81
(CONCENTRATIONS FOR CYANIDE AND PHENOL IN UG/L, ALL OTHERS IN MG/L)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
010	POTASSIUM	2	2	5.00 - 43.00	14.66	6.24	0.06 -3844.45
010	BORON	155	155	0.10 - 0.80	0.40	1.30	0.38 - 0.41
010	PHOSPHATE	1	0	< 0.10	< 0.10	?	?
010	CYANIDE	143	140	< 0.10 - 80.00	3.60	3.42	2.94 - 4.42
010	METH. BLUE ACTIVE SUBS	147	92	< 0.10 - 0.12	0.02	3.68	0.01 - 0.02
010	PHENOL	118	105	< 1.00 - 8.00	1.29	2.32	1.10 - 1.52
010	AMMONIA NITROGEN	513	242	< 0.10 - 7.10	0.27	5.61	0.22 - 0.33
010	ORGANIC NITROGEN	480	458	< 0.10 - 2.80	0.55	2.32	0.51 - 0.59
010	TOT KJELDAHL NITROGEN	488	475	< 0.10 - 7.40	1.03	2.55	0.95 - 1.12
010	NITRATE NITROGEN	148	148	0.10 - 18.00	1.73	3.96	1.39 - 2.17
010	FREE CHLORINE RESIDUAL	371	169	< 0.10 - 8.00	0.09	9.54	0.06 - 0.13
010	TOTAL CHLORINE RESID.	579	573	< 0.10 - 28.00	1.99	2.45	1.85 - 2.14
22A	TOTAL DISS.SOLIDS	145	145	622.00 -1248.00	892.12	1.13	874.18 - 910.43
22A	TOTAL HARDNESS	163	163	170.00 - 380.00	240.45	1.20	233.85 - 247.24
22A	MAGNESIUM	4	0	< 0.10	< 0.10	?	?
22A	SODIUM	623	623	100.00 - 280.00	182.26	1.20	179.66 - 184.91
22A	POTASSIUM	0	0	< 0.10	< 0.10	?	?
22A	BORON	2	0	< 0.10	< 0.10	?	?
22A	PHOSPHATE	51	13	< 0.10 - 1.20	0.02	4.92	0.01 - 0.05
22A	CYANIDE	0	0	< 0.10	< 0.10	?	?
22A	METH. BLUE ACTIVE SUBS	0	0	< 0.10	< 0.10	?	?
22A	PHENOL	103	97	< 1.00 - 10.00	2.37	2.06	2.05 - 2.74
22A	AMMONIA NITROGEN	115	113	< 0.10 - 44.30	3.38	2.92	2.77 - 4.11
22A	ORGANIC NITROGEN	115	113	< 0.10 - 2.40	0.60	1.40	0.56 - 0.64
22A	TOT KJELDAHL NITROGEN	114	114	0.50 - 44.70	4.46	2.14	3.88 - 5.13
22A	NITRATE NITROGEN	136	135	< 0.10 - 36.00	3.47	4.79	2.66 - 4.52
22A	FREE CHLORINE RESIDUAL	0	0	< 0.10	< 0.10	?	?
22A	TOTAL CHLORINE RESID.	1	1	?	?	?	?
22B	TOTAL DISS.SOLIDS	146	145	< 1.00 - 310.00	89.84	1.57	83.51 - 96.65
22B	TOTAL HARDNESS	165	163	< 1.00 - 90.00	8.32	2.18	7.38 - 9.38
22B	MAGNESIUM	49	12	< 0.10 - 1.40	0.02	7.71	0.01 - 0.07
22B	SODIUM	619	619	10.00 - 130.00	22.32	1.37	21.77 - 22.88
22B	POTASSIUM	53	49	< 0.10 - 23.00	1.13	1.98	0.94 - 1.37
22B	BORON	52	52	0.40 - 0.90	0.52	1.22	0.50 - 0.55
22B	PHOSPHATE	53	1	< 0.10	< 0.10	?	?
22B	CYANIDE	43	38	< 0.10 - 41.00	2.26	3.34	1.54 - 3.31
22B	METH. BLUE ACTIVE SUBS	50	2	0.10 - 0.10	0.10	?	?
22B	PHENOL	120	68	< 1.00 - 4.70	0.25	4.52	0.18 - 0.36
22B	AMMONIA NITROGEN	302	234	< 0.10 - 7.60	0.58	3.14	0.50 - 0.68
22B	ORGANIC NITROGEN	143	87	< 0.10 - 2.20	0.09	2.97	0.07 - 0.11
22B	TOT KJELDAHL NITROGEN	151	146	< 0.10 - 8.20	0.90	2.46	0.78 - 1.04
22B	NITRATE NITROGEN	135	130	< 0.10 - 12.00	1.73	4.31	1.35 - 2.22
22B	FREE CHLORINE RESIDUAL	30	1	< 0.10	< 0.10	?	?
22B	TOTAL CHLORINE RESID.	40	38	< 0.10 - 0.80	0.29	1.56	0.25 - 0.33

WATER FACTORY 21
SUMMARY DATA FOR GENERAL PARAMETERS FILE 2
FOR PERIOD FROM 1MAR78 TO 1APR81
(UNITS ARE SHOWN WITH CHEMICAL ANALYSIS NAME-(UNITS))

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	TOT COLI (10E5/100ML)	127	127	0.1 - 380.	4.2	5.1	3.1 - 5.5
001	FEC COLI (10E3/100ML)	127	117	< 0.0 - 8300.	42.9	8.5	29.1 - 63.2
001	COLOR (UNITS)	145	144	< 5.00 - 55.00	34.91	1.23	33.76 - 36.09
001	FLUORIDE (MG/L)	121	121	0.52 - 2.80	1.27	1.23	1.22 - 1.32
001	DIS. SULFIDE (MG/L)	46	9	< 1.00 - 4.10	0.46	2.31	0.24 - 0.85
001	SILICATE (MG/L)	56	56	20.00 - 29.00	24.15	1.12	23.47 - 24.85
001	PH (SCALE 1-14)	744	744	6.07 - 8.03	7.35	1.03	7.33 - 7.36
001	ELE. CONDUCTIVITY	800	800	379.0 - 2867.	1485.8	1.2	1467.8 -1504.0
001	CHLORIDE (MG/L)	263	263	164.50 - 369.40	235.76	1.18	231.11 -240.50
001	CALCIUM (MG/L)	400	400	59.20 - 146.00	86.43	1.17	85.13 - 87.75
001	CARBONATE (MG/L)	3	0	< 0.00	< 0.00	?	?
001	HYDROXIDE (MG/L CACO3)	3	0	< 0.00	< 0.00	?	?
001	BI-CARBONATE (MG/L)	358	358	76.00 - 430.00	203.68	1.43	196.31 -211.32
001	SULFATE (MG/L)	258	258	120.00 - 486.00	268.85	1.32	259.94 -278.06
002	TOT COLI (MPN/100ML)	120	53	< 0.30 - 510.00	0.33	15.96	0.16 - 0.69
002	FEC COLI (MPN/100ML)	120	14	< 0.30 - 59.00	0.01	45.47	0.00 - 0.05
002	COLOR (UNITS)	32	32	10.00 - 27.00	17.79	1.30	16.26 - 19.46
002	FLUORIDE (MG/L)	26	26	0.39 - 1.01	0.88	1.20	0.82 - 0.94
002	DIS. SULFIDE (MG/L)	0	0	< 1.00	< 1.00	?	?
002	SILICATE (MG/L)	57	57	6.80 - 20.00	13.11	1.23	12.42 - 13.83
002	PH (SCALE 1-14)	746	746	1.00 - 11.98	10.93	1.05	10.90 - 10.97
002	ELE. CONDUCTIVITY	811	811	1000.0 - 7630.	1562.2	1.2	1541.5 -1583.3
002	CHLORIDE (MG/L)	185	185	176.50 - 398.40	262.83	1.12	258.63 -267.09
002	CALCIUM (MG/L)	362	362	56.90 - 368.70	89.53	1.25	87.48 - 91.63
002	CARBONATE (MG/L)	361	361	24.00 - 160.00	63.55	1.44	61.22 - 65.98
002	HYDROXIDE (MG/L CACO3)	361	361	4.00 - 530.00	99.94	1.82	93.96 -106.30
002	BI-CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
002	SULFATE (MG/L)	178	178	170.00 - 416.00	260.83	1.18	254.62 -267.18
003	TOT COLI (MPN/100ML)	0	0	< 0.30	< 0.30	?	?
003	FEC COLI (MPN/100ML)	0	0	< 0.30	< 0.30	?	?
003	COLOR (UNITS)	0	0	< 5.00	< 5.00	?	?
003	FLUORIDE (MG/L)	0	0	< 0.10	< 0.10	?	?
003	DIS. SULFIDE (MG/L)	0	0	< 1.00	< 1.00	?	?
003	SILICATE (MG/L)	0	0	< 1.00	< 1.00	?	?
003	PH (SCALE 1-14)	16	16	10.79 - 11.24	11.06	1.01	11.00 - 11.12
003	ELE. CONDUCTIVITY	0	0	< 0.00	< 0.00	?	?
003	CHLORIDE (MG/L)	0	0	< 0.00	< 0.00	?	?
003	CALCIUM (MG/L)	0	0	< 0.00	< 0.00	?	?
003	CARBONATE (MG/L)	15	15	48.00 - 88.00	70.87	1.18	64.55 - 77.80
003	HYDROXIDE (MG/L CACO3)	15	15	68.00 - 134.00	97.33	1.25	85.93 -110.24
003	BI-CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
003	SULFATE (MG/L)	0	0	< 0.00	< 0.00	?	?

WATER FACTORY 21
SUMMARY DATA FOR GENERAL PARAMETERS FILE 2
FOR PERIOD FROM 1MAR78 TO 1APR81
(UNITS ARE SHOWN WITH CHEMICAL ANALYSIS NAME-(UNITS))

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
004	TOT COLI (MPN/100ML)	0	0	< 0.30	< 0.30	?	?
004	FEC COLI (MPN/100ML)	0	0	< 0.30	< 0.30	?	?
004	COLOR (UNITS)	22	22	10.00 - 22.00	16.61	1.30	14.77 - 18.67
004	FLUORIDE (MG/L)	22	22	0.41 - 1.08	0.84	1.25	0.76 - 0.92
004	DIS. SULFIDE (MG/L)	1	0	< 1.00	< 1.00	?	?
004	SILICATE (MG/L)	21	21	6.50 - 19.00	13.00	1.23	11.84 - 14.27
004	PH (SCALE 1-14)	270	270	1.00 - 11.88	10.90	1.06	10.83 - 10.98
004	ELE. CONDUCTIVITY	73	73	1150.0 - 2190.	1685.5	1.1	1643.6 -1728.5
004	CHLORIDE (MG/L)	179	179	212.70 - 354.50	264.43	1.11	260.45 -268.47
004	CALCIUM (MG/L)	182	182	54.50 - 296.60	82.04	1.30	79.01 - 85.18
004	CARBONATE (MG/L)	198	198	40.00 - 140.00	77.99	1.25	75.58 - 80.47
004	HYDROXIDE (MG/L CACO3)	198	198	40.00 - 710.00	115.67	1.50	109.28 -122.44
004	BI-CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
004	SULFATE (MG/L)	173	173	23.00 - 304.00	256.40	1.26	247.73 -265.38
005	TOT COLI (MPN/100ML)	0	0	< 0.30	< 0.30	?	?
005	FEC COLI (MPN/100ML)	0	0	< 0.30	< 0.30	?	?
005	COLOR (UNITS)	0	0	< 5.00	< 5.00	?	?
005	FLUORIDE (MG/L)	0	0	< 0.10	< 0.10	?	?
005	DIS. SULFIDE (MG/L)	0	0	< 1.00	< 1.00	?	?
005	SILICATE (MG/L)	0	0	< 1.00	< 1.00	?	?
005	PH (SCALE 1-14)	566	566	3.00 - 10.77	7.62	1.06	7.58 - 7.66
005	ELE. CONDUCTIVITY	745	745	1100.0 - 3413.	1451.3	1.2	1434.0 -1468.7
005	CHLORIDE (MG/L)	182	182	212.70 - 343.90	276.27	1.10	272.49 -280.09
005	CALCIUM (MG/L)	344	344	48.10 - 310.00	89.92	1.32	87.34 - 92.58
005	CARBONATE (MG/L)	7	7	44.00 - 70.00	55.26	1.24	45.63 - 66.93
005	HYDROXIDE (MG/L CACO3)	2	2	4.00 - 18.00	8.49	3.60	0.17 -416.17
005	BI-CARBONATE (MG/L)	340	337	< 0.00 - 352.00	108.94	1.84	102.10 -116.24
005	SULFATE (MG/L)	176	176	180.00 - 950.00	286.75	1.32	275.31 -298.66
006	TOT COLI (MPN/100ML)	505	61	< 0.30 - ******	0.00	335.27	0.00 - 0.00
006	FEC COLI (MPN/100ML)	519	26	< 0.30 - 220.00	0.00	160.31	0.00 - 0.00
006	COLOR (UNITS)	27	27	8.00 - 25.00	14.90	1.32	13.35 - 16.62
006	FLUORIDE (MG/L)	25	25	0.43 - 1.10	0.85	1.20	0.79 - 0.92
006	DIS. SULFIDE (MG/L)	0	0	< 1.00	< 1.00	?	?
006	SILICATE (MG/L)	25	25	9.20 - 18.00	13.93	1.17	13.06 - 14.87
006	PH (SCALE 1-14)	214	214	3.28 - 9.26	7.59	1.08	7.51 - 7.67
006	ELE. CONDUCTIVITY	183	183	177.0 - 3510.	1828.5	1.2	1786.5 -1871.3
006	CHLORIDE (MG/L)	181	181	212.70 - 361.60	279.09	1.11	275.04 -283.20
006	CALCIUM (MG/L)	340	340	52.10 - 251.50	85.26	1.23	83.43 - 87.13
006	CARBONATE (MG/L)	7	7	40.00 - 76.00	48.56	1.34	37.51 - 62.87
006	HYDROXIDE (MG/L CACO3)	0	0	< 0.00	< 0.00	?	?
006	BI-CARBONATE (MG/L)	343	341	< 0.00 - 286.00	104.57	1.07	97.83 -111.76
006	SULFATE (MG/L)	175	175	170.00 - 875.00	285.36	1.31	274.07 -297.12
008	TOT COLI (MPN/100ML)	241	118	< 0.30 - 66.00	0.79	8.31	0.54 - 1.15
008	FEC COLI (MPN/100ML)	245	3	< 0.30 - 8.00	0.00	176.62	0.00 - 0.06

WATER FACTORY 21
SUMMARY DATA FOR GENERAL PARAMETERS FILE 2
FOR PERIOD FROM 1MAR78 TO 1APR81
(UNITS ARE SHOWN WITH CHEMICAL ANALYSIS NAME-(UNITS))

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
008	COLOR (UNITS)	22	5	< 5.00 - 9.00	4.69	1.42	3.13 - 7.03
008	FLUORIDE (MG/L)	20	20	0.51 - 1.18	0.86	1.23	0.78 - 0.94
008	DIS. SULFIDE (MG/L)	36	0	< 1.00	< 1.00	?	?
008	SILICATE (MG/L)	20	20	10.00 - 18.00	13.69	1.18	12.67 - 14.78
008	PH (SCALE 1-14)	451	451	5.94 - 8.53	7.14	1.04	7.12 - 7.17
008	ELE. CONDUCTIVITY	1	1	?	?	?	?
008	CHLORIDE (MG/L)	1	1	?	?	?	?
008	CALCIUM (MG/L)	0	0	< 0.00	< 0.00	?	?
008	CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
008	HYDROXIDE (MG/L CACO3)	0	0	< 0.00	< 0.00	?	?
008	BI-CARBONATE (MG/L)	7	7	88.00 - 174.00	133.52	1.28	107.23 -166.25
008	SULFATE (MG/L)	1	0	< 0.00	< 0.00	?	?
009	TOT COLI (MPN/100ML)	346	13	< 0.30 - 17.00	0.00	17.45	0.00 - 0.02
009	FEC COLI (MPN/100ML)	349	0	< 0.30	< 0.30	?	?
009	COLOR (UNITS)	99	4	< 5.00 - 10.00	1.87	1.98	0.73 - 4.84
009	FLUORIDE (MG/L)	107	107	0.38 - 1.12	0.74	1.27	0.71 - 0.77
009	DIS. SULFIDE (MG/L)	39	0	< 1.00	< 1.00	?	?
009	SILICATE (MG/L)	45	45	11.00 - 19.00	13.88	1.14	13.36 - 14.42
009	PH (SCALE 1-14)	472	472	2.67 - 8.61	6.29	1.16	6.20 - 6.37
009	ELE. CONDUCTIVITY	554	554	1100.0 - 4088.	1467.7	1.2	1445.7 -1489.9
009	CHLORIDE (MG/L)	185	185	170.00 - 453.80	299.07	1.24	289.93 -308.50
009	CALCIUM (MG/L)	230	230	4.80 - 265.90	84.97	1.29	82.21 - 87.83
009	CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
009	HYDROXIDE (MG/L CACO3)	0	0	< 0.00	< 0.00	?	?
009	BI-CARBONATE (MG/L)	197	175	< 0.00 - 150.00	49.78	1.87	45.36 - 54.63
009	SULFATE (MG/L)	182	181	< 0.00 - 770.00	257.62	1.34	246.86 -268.85
010	TOT COLI (MPN/100ML)	509	44	< 0.30 - 262.00	0.01	24.66	0.00 - 0.02
010	FEC COLI (MPN/100ML)	510	13	1.00 - 1.00	1.00	?	?
010	COLOR (UNITS)	142	75	< 5.00 - 45.00	6.73	2.19	5.63 - 8.04
010	FLUORIDE (MG/L)	153	153	0.11 - 1.20	0.46	1.47	0.43 - 0.49
010	DIS. SULFIDE (MG/L)	1	0	< 1.00	< 1.00	?	?
010	SILICATE (MG/L)	0	0	< 1.00	< 1.00	?	?
010	PH (SCALE 1-14)	781	781	5.70 - 9.43	7.27	1.06	7.25 - 7.30
010	ELE. CONDUCTIVITY	875	875	108.0 - 1600.	504.4	1.6	489.8 - 519.4
010	CHLORIDE (MG/L)	261	261	16.00 - 195.10	62.46	1.60	59.00 - 66.12
010	CALCIUM (MG/L)	398	398	1.90 - 59.30	15.23	2.18	14.10 - 16.44
010	CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
010	HYDROXIDE (MG/L CACO3)	0	0	< 0.00	< 0.00	?	?
010	BI-CARBONATE (MG/L)	356	356	3.40 - 154.00	63.21	1.50	60.61 - 65.92
010	SULFATE (MG/L)	257	257	1.20 - 350.00	41.78	2.56	37.25 - 46.87
22A	TOT COLI (MPN/100ML)	338	82	< 0.30 - 100.00	0.16	16.08	0.09 - 0.30
22A	FEC COLI (MPN/100ML)	346	4	< 0.38 - 6.00	0.01	11.98	0.00 - 0.16
22A	COLOR (UNITS)	1	1	?	?	?	?
22A	FLUORIDE (MG/L)	0	0	< 0.10	< 0.10	?	?

WATER FACTORY 21
SUMMARY DATA FOR GENERAL PARAMETERS FILE 2
FOR PERIOD FROM 1MAR78 TO 1APR81
(UNITS ARE SHOWN WITH CHEMICAL ANALYSIS NAME-(UNITS))

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
22A	DIS. SULFIDE (MG/L)	1	0	< 1.00	< 1.00	?	?
22A	SILICATE (MG/L)	1	1	?	?	?	?
22A	PH (SCALE 1-14)	545	545	4.28 - 5.90	5.54	1.06	5.51 - 5.56
22A	ELE. CONDUCTIVITY	822	822	129.0 - 4370.	1467.8	1.2	1446.9 -1489.1
22A	CHLORIDE (MG/L)	527	527	42.00 - 375.00	223.39	1.22	219.65 -227.19
22A	CALCIUM (MG/L)	396	396	33.00 - 358.00	101.21	1.45	97.58 -104.98
22A	CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
22A	HYDROXIDE (MG/L CACO3)	0	0	< 0.00	< 0.00	?	?
22A	BI-CARBONATE (MG/L)	0	0	< 0.00	< 0.00	1.32	231.93 -243.25
22A	SULFATE (MG/L)	512	512	29.00 - 756.00	237.53		
22B	TOT COLI (MPN/100ML)	345	219	< 0.30 - 36.00	1.41	3.55	1.19 - 1.66
22B	FEC COLI (MPN/100ML)	346	1	< 0.30	< 0.30	?	?
22B	COLOR (UNITS)	56	0	< 5.00	< 5.00	?	?
22B	FLUORIDE (MG/L)	54	47	< 0.10 - 0.53	0.16	1.39	0.14 - 0.17
22B	DIS. SULFIDE (MG/L)	38	0	< 1.00	< 1.00	?	?
22B	SILICATE (MG/L)	51	51	2.00 - 6.00	3.36	1.37	3.08 - 3.66
22B	PH (SCALE 1-14)	684	684	5.12 - 7.32	6.64	1.06	6.62 - 6.67
22B	ELE. CONDUCTIVITY	791	791	60.0 - 356.	160.9	1.2	158.6 - 163.3
22B	CHLORIDE (MG/L)	510	510	8.50 - 95.70	27.97	1.38	27.21 - 28.76
22B	CALCIUM (MG/L)	383	201	< 0.00 - 22.00	1.93	2.20	1.73 - 2.15
22B	CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
22B	HYDROXIDE (MG/L CACO3)	0	0	< 0.00	< 0.00	?	?
22B	BI-CARBONATE (MG/L)	168	168	0.90 - 80.00	17.07	1.38	16.26 - 17.93
22B	SULFATE (MG/L)	496	474	< 0.00 - 520.00	2.81	2.34	2.60 - 3.04
22C	TOT COLI (MPN/100ML)	0	0	< 0.30	< 0.30	?	?
22C	FEC COLI (MPN/100ML)	0	0	< 0.30	< 0.30	?	?
22C	COLOR (UNITS)	0	0	< 5.00	< 5.00	?	?
22C	FLUORIDE (MG/L)	0	0	< 0.10	< 0.10	?	?
22C	DIS. SULFIDE (MG/L)	0	0	< 1.00	< 1.00	?	?
22C	SILICATE (MG/L)	0	0	< 1.00	< 1.00	?	?
22C	PH (SCALE 1-14)	0	0	< 0.00	< 0.00	?	?
22C	ELE. CONDUCTIVITY	0	0	< 0.00	< 0.00	?	?
22C	CHLORIDE (MG/L)	0	0	< 0.00	< 0.00	?	?
22C	CALCIUM (MG/L)	183	183	66.10 - 909.80	546.57	1.31	525.80 -568.15
22C	CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
22C	HYDROXIDE (MG/L CACO3)	0	0	< 0.00	< 0.00	?	?
22C	BI-CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
22C	SULFATE (MG/L)	1	0	< 0.00	< 0.00	?	?

WATER FACTORY 21
SUMMARY DATA FOR HEAVY METALS
FOR PERIOD FROM 1MAR78 TO 31MAR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	SILVER	66	66	0.20 - 10.00	1.53	1.99	1.29 - 1.80
001	ARSENIC	64	1	< 5.00	< 5.00	?	?
001	ALUMINUM	56	56	14.00 - 810.00	76.70	2.80	58.58 -100.43
001	BARIUM	66	66	15.00 - 300.00	81.15	1.91	69.45 - 94.82
001	BERYLLIUM	58	8	< 1.00 - 3.70	0.30	3.04	0.12 - 0.75
001	CADMIUM	66	66	1.50 - 87.00	10.87	2.61	8.62 - 13.71
001	COBALT	56	41	< 1.00 - 29.00	2.17	3.75	1.45 - 3.25
001	CHROMIUM	65	65	16.00 - 220.00	34.58	1.66	30.57 - 39.10
001	COPPER	66	66	11.00 - 240.00	51.31	1.81	44.45 - 59.23
001	IRON	66	66	41.00 - 400.00	111.88	1.66	99.07 -126.34
001	MERCURY	64	27	< 0.50 - 3.00	0.33	2.90	0.22 - 0.50
001	MANGANESE	66	66	22.00 - 180.00	51.60	1.56	46.35 - 57.46
001	NICKEL	58	58	25.00 - 360.00	76.57	1.70	66.83 - 87.73
001	LEAD	66	66	1.50 - 36.00	5.04	2.03	4.25 - 5.98
001	SELENIUM	64	1	< 5.00	< 5.00	?	?
001	ZINC	65	30	<100.00 - 260.00	88.15	1.49	76.43 -101.67
002	SILVER	35	32	< 0.10 - 7.30	0.37	3.65	0.23 - 0.58
002	ARSENIC	33	1	< 5.00	< 5.00	?	?
002	ALUMINUM	25	23	< 1.00 - 370.00	22.91	5.08	11.35 - 46.21
002	BARIUM	35	35	3.60 - 120.00	26.30	2.27	20.04 - 34.52
002	BERYLLIUM	27	3	< 1.00 - 1.50	0.37	2.01	0.10 - 1.34
002	CADMIUM	35	35	0.30 - 20.00	2.65	3.33	1.78 - 3.95
002	COBALT	25	15	< 1.00 - 77.00	1.15	7.19	0.39 - 3.40
002	CHROMIUM	35	35	2.00 - 130.00	7.50	2.07	5.89 - 9.54
002	COPPER	35	35	2.00 - 51.00	11.31	2.46	8.40 - 15.24
002	IRON	35	35	3.00 - 94.00	16.96	2.21	13.04 - 22.05
002	MERCURY	33	12	< 0.50 - 5.00	0.22	3.75	0.10 - 0.51
002	MANGANESE	35	33	< 0.10 - 41.00	1.52	5.00	0.88 - 2.63
002	NICKEL	27	27	13.00 - 67.00	27.03	1.53	22.87 - 31.94
002	LEAD	35	18	< 1.00 - 20.00	1.06	4.85	0.49 - 2.33
002	SELENIUM	33	0	< 5.00	< 5.00	?	?
002	ZINC	33	1	<100.00	<100.00	?	?
006	SILVER	32	30	< 0.10 - 3.30	0.51	3.31	0.34 - 0.79
006	ARSENIC	30	1	< 5.00	< 5.00	?	?
006	ALUMINUM	25	24	< 1.00 - 260.00	27.24	3.73	15.66 - 47.39
006	BARIUM	32	32	4.50 - 95.00	26.35	2.16	20.19 - 34.39
006	BERYLLIUM	27	2	< 1.00 - 1.70	0.24	2.69	0.01 - 4.76
006	CADMIUM	32	32	0.20 - 18.00	2.13	3.21	1.42 - 3.19
006	COBALT	25	14	< 1.00 - 27.00	1.24	5.67	0.46 - 3.33
006	CHROMIUM	32	32	1.60 - 86.00	6.37	1.97	5.04 - 8.06
006	COPPER	32	32	6.00 - 65.00	20.37	1.77	16.73 - 24.81
006	IRON	32	32	5.00 - 440.00	86.49	2.72	61.13 -122.36
006	MERCURY	30	14	< 0.50 - 1.80	0.40	2.18	0.26 - 0.62
006	MANGANESE	32	32	0.70 - 100.00	4.55	2.65	3.25 - 6.38

WATER FACTORY 21
SUMMARY DATA FOR HEAVY METALS
FOR PERIOD FROM 1MAR78 TO 31MAR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
006	NICKEL	27	27	11.00 - 62.00	24.67	1.63	20.36 - 29.89
006	LEAD	32	14	< 1.00 - 17.00	1.09	4.75	0.45 - 2.66
006	SELENIUM	30	0	< 5.00	< 5.00	?	?
006	ZINC	32	4	<100.00 - 320.00	58.34	2.34	17.92 -189.99
008	SILVER	26	24	< 0.10 - 3.10	0.37	3.06	0.23 - 0.60
008	ARSENIC	25	2	< 5.00 - 10.00	0.56	4.32	0.01 - 48.06
008	ALUMINUM	22	22	10.00 - 920.00	44.73	3.08	27.23 - 73.48
008	BARIUM	26	26	3.10 - 100.00	33.45	2.22	24.21 - 46.20
008	BERYLLIUM	23	1	< 1.00	< 1.00	?	?
008	CADMIUM	26	26	0.20 - 12.00	1.70	3.02	1.09 - 2.65
008	COBALT	22	9	< 1.00 - 25.00	0.56	9.48	0.10 - 3.05
008	CHROMIUM	26	26	1.00 - 53.00	3.78	2.40	2.65 - 5.39
008	COPPER	26	25	< 1.00 - 41.00	6.08	2.51	4.16 - 8.88
008	IRON	26	26	11.00 - 98.00	28.70	1.71	23.10 - 35.67
008	MERCURY	25	14	< 0.50 - 3.30	0.40	2.61	0.23 - 0.70
008	MANGANESE	26	26	0.70 - 28.00	3.37	2.52	2.32 - 4.90
008	NICKEL	23	23	8.50 - 58.00	16.30	1.45	13.88 - 19.14
008	LEAD	26	11	< 1.00 - 20.00	0.69	5.95	0.21 - 2.24
008	SELENIUM	25	0	< 5.00	< 5.00	?	?
008	ZINC	26	1	<100.00	<100.00	?	?
009	SILVER	46	41	< 0.10 - 8.20	0.48	3.62	0.32 - 0.71
009	ARSENIC	46	0	< 5.00	< 5.00	?	?
009	ALUMINUM	46	46	1.00 - 600.00	30.92	3.83	20.97 - 45.58
009	BARIUM	46	46	17.00 - 100.00	42.53	1.66	36.73 - 49.25
009	BERYLLIUM	46	3	< 1.00 - 2.70	0.41	2.40	0.08 - 2.04
009	CADMIUM	46	46	0.30 - 5.40	1.24	2.20	0.98 - 1.55
009	COBALT	46	19	< 1.00 - 34.00	0.66	8.44	0.24 - 1.84
009	CHROMIUM	46	46	0.80 - 110.00	6.54	2.77	4.88 - 8.78
009	COPPER	46	46	9.30 - 960.00	153.83	2.88	113.30 -208.86
009	IRON	45	45	17.00 - 530.00	51.29	1.98	42.03 - 62.60
009	MERCURY	46	21	< 0.50 - 3.60	0.57	2.15	0.40 - 0.81
009	MANGANESE	46	46	1.00 - 22.00	4.57	2.08	3.69 - 5.64
009	NICKEL	46	46	3.70 - 62.00	19.27	1.66	16.66 - 22.29
009	LEAD	46	39	< 1.00 - 120.00	4.52	4.04	2.91 - 7.00
009	SELENIUM	46	1	< 5.00	< 5.00	?	?
009	ZINC	46	13	<100.00 - 460.00	53.46	2.33	32.22 - 88.70
010	SILVER	118	107	< 0.10 - 5.40	0.45	3.52	0.35 - 0.57
010	ARSENIC	105	59	< 5.00 - 10.00	4.12	1.52	3.71 - 4.59
010	ALUMINUM	25	24	< 1.00 - 110.00	16.39	2.58	11.00 - 24.41
010	BARIUM	117	109	< 1.00 - 45.00	4.64	2.63	3.87 - 5.57
010	BERYLLIUM	28	3	5.00 - 5.00	5.00	?	?
010	CADMIUM	140	129	< 0.10 - 20.00	0.69	5.68	0.51 - 0.93
010	COBALT	25	8	< 1.00 - 5.70	0.12	9.42	0.02 - 0.75
010	CHROMIUM	118	93	< 1.00 - 130.00	2.14	6.63	1.46 - 3.14

WATER FACTORY 21
SUMMARY DATA FOR HEAVY METALS
FOR PERIOD FROM 1MAR78 TO 31MAR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
010	COPPER	117	115	< 1.00 - 330.00	8.62	2.70	7.18 - 10.33
010	IRON	138	135	< 1.00 - 660.00	21.90	2.19	19.19 - 25.00
010	MERCURY	107	72	< 0.50 - 5.00	0.47	3.41	0.35 - 0.62
010	MANGANESE	139	136	< 0.10 - 70.00	2.11	2.61	1.80 - 2.48
010	NICKEL	28	26	< 1.00 - 58.00	4.16	3.03	2.66 - 6.51
010	LEAD	118	82	< 1.00 - 20.00	0.86	4.05	0.63 - 1.16
010	SELENIUM	127	0	< 5.00	< 5.00	?	?
010	ZINC	121	19	<100.00 - 650.00	16.26	4.99	7.52 - 35.15
22A	SILVER	15	11	< 0.10 - 2.30	0.41	3.38	0.18 - 0.92
22A	ARSENIC	15	1	< 5.00	< 5.00	?	?
22A	ALUMINUM	14	13	< 1.00 - 650.00	34.71	3.81	15.57 - 77.34
22A	BARIUM	15	15	9.60 - 99.00	35.35	2.04	23.90 - 52.28
22A	BERYLLIUM	15	3	< 1.00 - 5.00	0.07	11.86	0.00 - 6.24
22A	CADMIUM	15	15	0.30 - 17.00	1.60	3.11	0.85 - 2.98
22A	COBALT	14	8	< 1.00 - 28.00	1.01	9.21	0.16 - 6.21
22A	CHROMIUM	15	13	< 1.00 - 10.00	2.35	2.34	1.41 - 3.91
22A	COPPER	15	15	3.60 - 16.00	8.87	1.57	6.93 - 11.37
22A	IRON	15	15	12.00 - 160.00	38.27	2.25	24.49 - 59.80
22A	MERCURY	15	9	< 0.50 - 2.30	0.68	1.83	0.43 - 1.08
22A	MANGANESE	15	15	0.40 - 9.70	1.44	2.45	0.88 - 2.36
22A	NICKEL	15	15	11.00 - 130.00	24.06	1.86	17.10 - 33.85
22A	LEAD	15	3	< 1.00 - 8.40	4.08	1.54	1.84 - 9.07
22A	SELENIUM	15	0	< 5.00	< 5.00	?	?
22A	ZINC	15	0	<100.00	<100.00	?	?
22B	SILVER	51	28	< 0.10 - 1.10	0.15	3.19	0.09 - 0.23
22B	ARSENIC	51	0	< 5.00	< 5.00	?	?
22B	ALUMINUM	50	40	< 1.00 - 140.00	6.12	3.60	4.12 - 9.11
22B	BARIUM	51	33	< 1.00 - 15.00	1.13	3.18	0.76 - 1.68
22B	BERYLLIUM	51	0	< 1.00	< 1.00	?	?
22B	CADMIUM	51	19	< 0.10 - 0.60	0.07	3.16	0.04 - 0.12
22B	COBALT	50	4	< 1.00 - 2.90	0.00	39.85	0.00 - 0.18
22B	CHROMIUM	51	29	< 1.00 - 38.00	0.82	5.24	0.44 - 1.53
22B	COPPER	51	47	< 1.00 - 27.00	3.92	2.16	3.15 - 4.89
22B	IRON	51	37	< 1.00 - 260.00	2.82	5.05	1.67 - 4.75
22B	MERCURY	50	15	< 0.50 - 2.20	0.28	2.79	0.16 - 0.50
22B	MANGANESE	51	27	< 0.10 - 28.00	0.13	13.29	0.05 - 0.36
22B	NICKEL	51	32	< 1.00 - 59.00	1.48	4.28	0.89 - 2.44
22B	LEAD	51	11	< 1.00 - 2.70	0.65	2.86	0.40 - 1.05
22B	SELENIUM	51	0	< 5.00	< 5.00	?	?
22B	ZINC	51	1	<100.00	<100.00	?	?

WATER FACTORY 21
SUMMARY DATA FOR TURBIDITY FILE
FOR PERIOD FROM 1MAR78 TO 1APR81
(CONCENTRATIONS ARE IN FTU, DETECTION LIMIT=0.01 FTU)

LOCATION	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
Q1	408	408	1.40 - 26.20	5.46	1.62	5.21 - 5.72
Q2	406	406	0.06 - 2.68	0.50	2.05	0.47 - 0.54
Q4	0	0	< 0.01	< 0.01	?	?
Q6	408	408	0.04 - 3.48	0.11	1.65	0.10 - 0.11
Q8	0	0	< 0.01	< 0.01	?	?
Q9	0	0	< 0.01	< 0.01	?	?
Q10	413	413	0.07 - 0.68	0.28	1.42	0.27 - 0.29
Q22A	0	0	< 0.01	< 0.01	?	?
Q22B	0	0	< 0.01	< 0.01	?	?

WATER FACTORY 21
SUMMARY DATA FOR TOTAL ORGANIC CARBON FILE 1
FOR PERIOD FROM 1MAR78 TO 31MAR81
(CONCENTRATIONS ARE IN MG/L, DETECTION LIMIT=20 UG/L)

LOCATION	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
Q1	254	252	< 0.02 - 24.00	13.57	1.21	13.26 - 13.90
Q2	257	255	< 0.02 - 20.50	10.55	1.25	10.27 - 10.84
Q4	13	13	3.10 - 13.20	9.78	1.39	8.03 - 11.90
Q6	254	252	< 0.02 - 18.00	10.67	1.24	10.39 - 10.96
Q8	271	269	< 0.02 - 14.50	5.35	1.43	5.13 - 5.59
Q9	118	118	2.00 - 10.30	5.78	1.35	5.48 - 6.10
Q10	143	143	0.20 - 6.00	1.47	1.55	1.37 - 1.58
Q22A	215	213	< 0.02 - 23.00	6.23	1.32	6.00 - 6.46
Q22B	214	206	< 0.02 - 20.00	1.04	2.30	0.93 - 1.17

WATER FACTORY 21
SUMMARY DATA FOR CHEMCIAL OXYGEN DEMAND FILE 1
FOR PERIOD FROM 1MAR78 TO 31MAR81
(CONCENTRATIONS ARE IN MG/L, DETECTION LIMIT=1.0 MG/L)

LOCATION	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
Q1	667	666	< 1.00 - 113.00	47.10	1.31	46.14 - 48.08
Q2	667	666	< 1.00 - 49.00	26.62	1.22	26.22 - 27.03
Q4	24	24	24.00 - 39.00	29.67	1.16	27.83 - 31.63
Q6	666	665	< 1.00 - 43.00	24.61	1.24	24.22 - 25.01
Q8	459	457	< 1.00 - 126.00	10.73	1.56	10.31 - 11.18
Q9	182	181	< 1.00 - 19.00	8.42	1.63	7.85 - 9.05
Q10	667	595	< 1.00 - 23.00	4.13	1.81	3.94 - 4.33
Q22A	634	633	< 1.00 - 30.20	13.34	1.33	13.04 - 13.64
Q22B	632	173	< 1.00 - 10.00	0.87	2.43	0.76 - 0.99

WATER FACTORY 21
SUMMARY DATA FOR VOA CONSTITUENTS
FOR PERIOD FROM 1MAR78 TO 9APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	CHLOROFORM	99	99	0.96 - 22.50	3.46	1.84	3.07 - 3.91
001	1,1,1-TRICHLOROETHANE	99	99	0.37 - 96.00	4.80	2.65	3.96 - 5.81
001	CARBON TETRACHLORIDE	99	37	<0.05 - 0.32	0.05	2.18	0.04 - 0.06
001	BROMODICHLOROMETHANE	98	97	<0.05 - 1.29	0.46	1.57	0.42 - 0.50
001	TRICHLOROETHYLENE	99	96	<0.05 - 27.00	1.07	2.87	0.87 - 1.32
001	DIBROMOCHLOROMETHANE	100	100	0.24 - 1.65	0.71	1.55	0.65 - 0.78
001	TETRACHLOROETHYLENE	101	101	0.41 - 67.00	3.62	2.97	2.93 - 4.47
001	BROMOFORM	96	72	<0.20 - 2.99	0.46	1.99	0.39 - 0.53
002	CHLOROFORM	54	54	1.72 - 58.90	4.71	1.76	4.05 - 5.47
002	1,1,1-TRICHLOROETHANE	55	55	0.45 - 18.00	3.56	2.71	2.74 - 4.63
002	CARBON TETRACHLORIDE	53	21	<0.05 - 0.21	0.05	2.03	0.04 - 0.07
002	BROMODICHLOROMETHANE	55	55	0.30 - 6.10	0.80	1.95	0.67 - 0.95
002	TRICHLOROETHYLENE	53	50	<0.05 - 4.40	0.87	2.54	0.67 - 1.12
002	DIBROMOCHLOROMETHANE	55	55	0.30 - 3.40	0.91	1.73	0.79 - 1.05
002	TETRACHLOROETHYLENE	55	55	0.41 - 54.00	2.86	2.88	2.16 - 3.79
002	BROMOFORM	51	40	<0.20 - 2.57	0.55	2.02	0.44 - 0.68
003	CHLOROFORM	5	5	0.30 - 0.80	0.55	1.50	0.35 - 0.88
003	1,1,1-TRICHLOROETHANE	5	3	<0.05 - 0.20	0.13	1.45	0.07 - 0.25
003	CARBON TETRACHLORIDE	5	0	<0.05	<0.05	?	?
003	BROMODICHLOROMETHANE	5	1	<0.05	<0.05	?	?
003	TRICHLOROETHYLENE	5	1	<0.05	<0.05	?	?
003	DIBROMOCHLOROMETHANE	5	1	<0.10	<0.10	?	?
003	TETRACHLOROETHYLENE	5	5	0.10 - 0.70	0.28	2.47	0.10 - 0.78
003	BROMOFORM	5	0	<0.20	<0.20	?	?
004	CHLOROFORM	49	49	0.22 - 17.70	0.88	2.39	0.69 - 1.12
004	1,1,1-TRICHLOROETHANE	49	41	<0.05 - 1.00	0.18	2.38	0.14 - 0.24
004	CARBON TETRACHLORIDE	48	19	<0.05 - 0.15	0.05	1.70	0.04 - 0.07
004	BROMODICHLOROMETHANE	49	26	<0.05 - 0.60	0.07	2.31	0.05 - 0.10
004	TRICHLOROETHYLENE	48	20	<0.05 - 3.20	0.03	12.23	0.01 - 0.11
004	DIBROMOCHLOROMETHANE	49	37	<0.10 - 0.70	0.17	1.85	0.14 - 0.21
004	TETRACHLOROETHYLENE	49	40	<0.05 - 0.54	0.14	1.95	0.11 - 0.17
004	BROMOFORM	47	17	<0.20 - 0.78	0.18	2.09	0.12 - 0.26
006	CHLOROFORM	57	57	0.40 - 98.00	7.94	3.02	5.96 -10.58
006	1,1,1-TRICHLOROETHANE	56	45	<0.05 - 30.00	0.17	5.35	0.10 - 0.28
006	CARBON TETRACHLORIDE	57	39	<0.05 - 0.90	0.10	2.69	0.07 - 0.14
006	BROMODICHLOROMETHANE	56	54	<0.05 - 79.00	3.91	4.22	2.66 - 5.74
006	TRICHLOROETHYLENE	44	10	<0.05 - 5.30	0.04	14.64	0.01 - 0.25
006	DIBROMOCHLOROMETHANE	57	54	<0.10 - 66.00	2.07	5.62	1.31 - 3.29
006	TETRACHLOROETHYLENE	55	48	<0.05 - 3.87	0.14	2.67	0.11 - 0.19
006	BROMOFORM	55	43	<0.20 - 8.90	0.90	3.37	0.63 - 1.30
007	CHLOROFORM	1	1	?	?	?	?

WATER FACTORY 21
SUMMARY DATA FOR VOA CONSTITUENTS
FOR PERIOD FROM 1MAR78 TC 9APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
007	1,1,1-TRICHLOROETHANE	1	1	?	?	?	?
007	CARBON TETRACHLORIDE	1	1	?	?	?	?
007	BROMODICHLOROMETHANE	1	1	?	?	?	?
007	TRICHLOROETHYLENE	0	0	<0.05	<0.05	?	?
007	DIBROMOCHLOROMETHANE	1	1	?	?	?	?
007	TETRACHLOROETHYLENE	1	1	?	?	?	?
007	BROMOFORM	1	1	?	?	?	?
008	CHLOROFORM	20	20	0.19 - 55.50	3.52	5.22	1.63 - 7.62
008	1,1,1-TRICHLOROETHANE	20	15	<0.05 - 0.49	0.14	2.10	0.10 - 0.21
008	CARBON TETRACHLORIDE	20	15	<0.05 - 0.25	0.07	2.01	0.05 - 0.10
008	BROMODICHLOROMETHANE	20	13	<0.05 - 30.20	0.93	8.78	0.23 - 3.40
008	TRICHLOROETHYLENE	16	6	<0.05 - 2.15	0.03	7.97	0.00 - 0.26
008	DIBROMOCHLOROMETHANE	19	12	<0.10 - 27.08	0.41	12.93	0.08 - 2.03
008	TETRACHLOROETHYLENE	19	10	<0.05 - 4.88	0.04	14.77	0.01 - 0.27
008	BROMOFORM	20	7	<0.20 - 5.33	0.17	9.33	0.02 - 1.27
009	CHLOROFORM	70	70	1.21 - 41.70	10.16	2.23	8.42 -12.25
009	1,1,1-TRICHLOROETHANE	69	59	<0.05 - 41.00	0.18	4.41	0.12 - 0.26
009	CARBON TETRACHLORIDE	67	60	<0.05 - 2.27	0.21	2.65	0.16 - 0.26
009	BROMODICHLOROMETHANE	69	69	0.14 - 34.90	4.41	3.31	3.33 - 5.85
009	TRICHLOROETHYLENE	54	16	<0.05 - 6.30	0.06	10.74	0.02 - 0.22
009	DIBROMOCHLOROMETHANE	70	70	0.26 - 31.32	2.76	3.29	2.09 - 3.64
009	TETRACHLOROETHYLENE	70	69	<0.05 - 7.60	0.71	2.73	0.56 - 0.90
009	BROMOFORM	66	56	<0.20 - 5.77	0.84	3.13	0.62 - 1.13
066	CHLOROFORM	2	2	3.20 - 4.00	3.58	1.21	2.01 - 6.37
066	1,1,1-TRICHLOROETHANE	2	2	0.10 - 0.20	0.14	1.80	0.02 - 0.85
066	CARBON TETRACHLORIDE	2	1	<0.05	<0.05	?	?
066	BROMODICHLOROMETHANE	2	2	1.20 - 1.60	1.39	1.28	0.66 - 2.92
066	TRICHLOROETHYLENE	1	0	<0.05	<0.05	?	?
066	DIBROMOCHLOROMETHANE	2	2	0.40 - 0.50	0.45	1.21	0.25 - 0.80
066	TETRACHLOROETHYLENE	2	2	0.10 - 0.20	0.14	1.80	0.02 - 0.85
066	BROMOFORM	2	0	<0.20	<0.20	?	?
21A	CHLOROFORM	13	13	3.20 - 21.00	5.50	1.74	3.95 - 7.65
21A	1,1,1-TRICHLOROETHANE	13	13	0.30 - 16.00	4.94	2.36	2.96 - 8.27
21A	CARBON TETRACHLORIDE	13	4	0.10 - 0.10	0.10	?	?
21A	BROMODICHLOROMETHANE	12	12	0.40 - 1.90	0.87	1.76	0.61 - 1.25
21A	TRICHLOROETHYLENE	12	12	0.50 - 4.90	1.52	2.28	0.91 - 2.55
21A	DIBROMOCHLOROMETHANE	13	13	0.60 - 1.70	0.82	1.32	0.70 - 0.97
21A	TETRACHLOROETHYLENE	13	13	0.80 - 3.00	1.49	1.55	1.15 - 1.94
21A	BROMOFORM	13	10	<0.20 - 1.00	0.63	1.49	0.48 - 0.84
21B	CHLOROFORM	13	13	3.40 - 17.00	5.52	1.55	4.25 - 7.16
21B	1,1,1-TRICHLOROETHANE	13	13	0.40 - 17.00	6.32	2.24	3.90 -10.24
21B	CARBON TETRACHLORIDE	13	5	0.10 - 0.10	0.10	?	?

WATER FACTORY 21
SUMMARY DATA FOR VOA CONSTITUENTS
FOR PERIOD FROM 1MAR78 TO 9APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
21B	BROMODICHLOROMETHANE	12	12	0.50 - 2.10	0.95	1.66	0.69 - 1.31
21B	TRICHLOROETHYLENE	12	12	0.70 - 5.10	1.71	2.09	1.08 - 2.72
21B	DIBROMOCHLOROMETHANE	13	13	0.60 - 1.90	0.90	1.37	0.75 - 1.09
21B	TETRACHLOROETHYLENE	13	13	0.70 - 4.60	1.80	1.70	1.31 - 2.48
21B	BROMOFORM	13	10	<0.20 - 1.50	0.65	1.73	0.44 - 0.96
22A	CHLOROFORM	64	64	3.20 - 39.40	10.41	1.95	8.84 -12.27
22A	1,1,1-TRICHLOROETHANE	63	55	<0.05 - 45.00	0.18	4.09	0.12 - 0.26
22A	CARBON TETRACHLORIDE	63	28	<0.05 - 0.30	0.07	2.06	0.05 - 0.09
22A	BROMODICHLOROMETHANE	64	64	1.00 - 23.70	4.27	2.62	3.38 - 5.41
22A	TRICHLOROETHYLENE	49	9	<0.05 - 6.20	0.11	7.76	0.02 - 0.49
22A	DIBROMOCHLOROMETHANE	64	63	<0.10 - 22.10	2.08	3.45	1.53 - 2.82
22A	TETRACHLOROETHYLENE	63	40	<0.05 - 5.20	0.08	3.59	0.05 - 0.12
22A	BROMOFORM	63	45	<0.20 - 7.99	0.78	3.05	0.51 - 0.97
22B	CHLOROFORM	94	94	0.30 - 19.70	1.81	2.16	1.55 - 2.11
22B	1,1,1-TRICHLOROETHANE	94	51	<0.05 - 35.00	0.05	9.13	0.03 - 0.09
22B	CARBON TETRACHLORIDE	92	36	<0.05 - 0.20	0.06	1.58	0.05 - 0.07
22B	BROMODICHLOROMETHANE	93	91	<0.05 - 9.28	0.69	2.82	0.56 - 0.86
22B	TRICHLOROETHYLENE	82	12	<0.05 - 5.60	0.01	21.45	0.00 - 0.06
22B	DIBROMOCHLOROMETHANE	93	87	<0.10 - 12.54	0.74	3.24	0.58 - 0.95
22B	TETRACHLOROETHYLENE	93	52	<0.05 - 3.40	0.06	3.37	0.04 - 0.09
22B	BROMOFORM	93	52	<0.20 - 4.29	0.32	3.76	0.22 - 0.45
22R	CHLOROFORM	42	42	4.90 - 39.90	14.79	1.78	12.43 -17.60
22R	1,1,1-TRICHLOROETHANE	41	33	<0.05 - 5.10	0.19	4.23	0.11 - 0.31
22R	CARBON TETRACHLORIDE	41	19	<0.05 - 0.30	0.07	1.88	0.05 - 0.10
22R	BROMODICHLOROMETHANE	42	42	1.10 - 29.90	7.62	2.34	5.90 - 9.86
22R	TRICHLOROETHYLENE	28	0	<0.05	<0.05	?	?
22R	DIBROMOCHLOROMETHANE	42	42	0.30 - 26.90	3.91	3.14	2.76 - 5.52
22R	TETRACHLOROETHYLENE	41	24	<0.05 - 1.50	0.08	3.44	0.05 - 0.14
22R	BROMOFORM	41	35	<0.20 - 11.30	1.10	3.10	0.75 - 1.59
239	CHLOROFORM	30	30	4.70 - 28.00	10.51	1.69	8.70 -12.69
239	1,1,1-TRICHLOROETHANE	29	24	<0.05 - 2.70	0.14	4.04	0.08 - 0.26
239	CARBON TETRACHLORIDE	29	12	<0.05 - 0.20	0.07	1.81	0.05 - 0.11
239	BROMODICHLOROMETHANE	30	30	1.00 - 17.00	5.13	2.21	3.86 - 6.81
239	TRICHLOROETHYLENE	27	0	<0.05	<0.05	?	?
239	DIBROMOCHLOROMETHANE	30	30	0.30 - 9.00	2.27	2.68	1.59 - 3.23
239	TETRACHLOROETHYLENE	29	17	<0.05 - 8.80	0.06	9.19	0.02 - 0.17
239	BROMOFORM	29	21	<0.20 - 2.50	0.67	2.08	0.48 - 0.94
243	CHLOROFORM	30	30	5.10 - 28.00	11.22	1.72	9.24 -13.62
243	1,1,1-TRICHLOROETHANE	29	24	<0.05 - 4.70	0.21	4.40	0.11 - 0.39
243	CARBON TETRACHLORIDE	29	14	<0.05 - 0.30	0.06	2.27	0.04 - 0.10
243	BROMODICHLOROMETHANE	30	30	1.30 - 16.00	5.27	2.14	4.01 - 6.93
243	TRICHLOROETHYLENE	26	0	<0.05	<0.05	?	?

WATER FACTORY 21
SUMMARY DATA FOR VOA CONSTITUENTS
FOR PERIOD FROM 1MAR78 TO 9APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
243	DIBROMOCHLOROMETHANE	30	30	0.30 - 8.90	2.30	2.62	1.63 - 3.24
243	TETRACHLOROETHYLENE	29	19	<0.05 - 1.60	0.08	3.81	0.04 - 0.16
243	BROMOFORM	28	20	<0.20 - 2.80	0.64	2.31	0.43 - 0.95
246	CHLOROFORM	30	30	4.90 - 35.00	11.57	1.79	9.40 -14.25
246	1,1,1-TRICHLOROETHANE	29	20	<0.05 - 1.80	0.20	3.96	0.11 - 0.38
246	CARBON TETRACHLORIDE	29	10	<0.05 - 0.30	0.05	2.45	0.03 - 0.10
246	BROMODICHLOROMETHANE	30	30	1.20 - 17.00	5.38	2.19	4.07 - 7.12
246	TRICHLOROETHYLENE	27	2	<0.05 - 2.50	0.09	5.29	0.00 -14.17
246	DIBROMOCHLOROMETHANE	29	29	0.40 - 9.50	2.55	2.49	1.80 - 3.60
246	TETRACHLOROETHYLENE	29	18	<0.05 - 1.20	0.08	3.05	0.04 - 0.13
246	BROMOFORM	29	20	<0.20 - 3.40	0.73	2.20	0.51 - 1.06
702	CHLOROFORM	1	1	?	?	?	?
702	1,1,1-TRICHLOROETHANE	1	1	?	?	?	?
702	CARBON TETRACHLORIDE	1	1	?	?	?	?
702	BROMODICHLOROMETHANE	1	1	?	?	?	?
702	TRICHLOROETHYLENE	0	0	<0.05	<0.05	?	?
702	DIBROMOCHLOROMETHANE	1	1	?	?	?	?
702	TETRACHLOROETHYLENE	1	1	?	?	?	?
702	BROMOFORM	1	1	?	?	?	?
703	CHLOROFORM	11	11	11.20 - 45.00	22.00	1.60	16.13 -30.01
703	1,1,1-TRICHLOROETHANE	11	9	<0.05 - 1.59	0.20	2.82	0.09 - 0.43
703	CARBON TETRACHLORIDE	11	6	<0.05 - 0.21	0.08	1.86	0.04 - 0.14
703	BROMODICHLOROMETHANE	11	11	7.53 - 23.00	14.84	1.52	11.23 -19.62
703	TRICHLOROETHYLENE	4	0	<0.05	<0.05	?	?
703	DIBROMOCHLOROMETHANE	11	11	3.79 - 18.70	9.38	1.83	6.29 -14.00
703	TETRACHLOROETHYLENE	11	7	<0.05 - 7.10	0.09	6.77	0.02 - 0.51
703	BROMOFORM	11	10	<0.20 - 6.05	2.06	2.25	1.16 - 3.66
704	CHLOROFORM	1	1	?	?	?	?
704	1,1,1-TRICHLOROETHANE	1	1	?	?	?	?
704	CARBON TETRACHLORIDE	1	0	<0.05	<0.05	?	?
704	BROMODICHLOROMETHANE	1	1	?	?	?	?
704	TRICHLOROETHYLENE	1	0	<0.05	<0.05	?	?
704	DIBROMOCHLOROMETHANE	1	1	?	?	?	?
704	TETRACHLOROETHYLENE	1	1	?	?	?	?
704	BROMOFORM	1	0	<0.20	<0.20	?	?
705	CHLOROFORM	31	31	1.00 - 41.40	9.37	2.71	6.59 -13.31
705	1,1,1-TRICHLOROETHANE	32	30	<0.05 - 13.00	0.23	5.07	0.13 - 0.41
705	CARBON TETRACHLORIDE	32	11	<0.05 - 0.40	0.05	2.58	0.02 - 0.09
705	BROMODICHLOROMETHANE	31	31	0.20 - 19.00	3.87	3.46	2.50 - 5.98
705	TRICHLOROETHYLENE	26	6	<0.05 - 3.70	0.58	2.78	0.21 - 1.61
705	DIBROMOCHLOROMETHANE	32	32	0.20 - 12.30	1.66	3.74	1.05 - 2.63
705	TETRACHLOROETHYLENE	31	25	<0.05 - 5.50	0.16	3.98	0.09 - 0.29

WATER FACTORY 21
SUMMARY DATA FOR VOA CONSTITUENTS
FOR PERIOD FROM 1MAR78 TO 9APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
705	BROMOFORM	31	17	<0.20 - 2.89	0.51	2.56	0.32 - 0.83
706	CHLOROFORM	1	1	?	?	?	?
706	1,1,1-TRICHLOROETHANE	1	1	?	?	?	?
706	CARBON TETRACHLORIDE	1	0	<0.05	<0.05	?	?
706	BROMODICHLOROMETHANE	1	1	?	?	?	?
706	TRICHLOROETHYLENE	1	0	<0.05	<0.05	?	?
706	DIBROMOCHLOROMETHANE	1	1	?	?	?	?
706	TETRACHLOROETHYLENE	1	1	?	?	?	?
706	BROMOFORM	1	1	?	?	?	?
707	CHLOROFORM	1	1	?	?	?	?
707	1,1,1-TRICHLOROETHANE	1	1	?	?	?	?
707	CARBON TETRACHLORIDE	1	0	<0.05	<0.05	?	?
707	BROMODICHLOROMETHANE	1	1	?	?	?	?
707	TRICHLOROETHYLENE	1	0	<0.05	<0.05	?	?
707	DIBROMOCHLOROMETHANE	1	1	?	?	?	?
707	TETRACHLOROETHYLENE	1	1	?	?	?	?
707	BROMOFORM	1	1	?	?	?	?
712	CHLOROFORM	15	15	1.00 - 21.00	6.29	2.33	3.95 -10.02
712	1,1,1-TRICHLOROETHANE	16	11	<0.05 - 4.30	0.21	6.29	0.06 - 0.72
712	CARBON TETRACHLORIDE	16	5	0.10 - 0.10	0.10	?	?
712	BROMODICHLOROMETHANE	16	15	<0.05 - 13.00	1.07	4.42	0.47 - 2.42
712	TRICHLOROETHYLENE	16	5	<0.05 - 2.90	0.74	2.53	0.25 - 2.13
712	DIBROMOCHLOROMETHANE	16	9	<0.10 - 4.40	0.47	3.64	0.18 - 1.24
712	TETRACHLOROETHYLENE	15	14	<0.05 - 24.00	0.22	5.24	0.08 - 0.56
712	BROMOFORM	15	5	<0.20 - 3.40	0.07	7.87	0.01 - 0.78
716	CHLOROFORM	1	1	?	?	?	?
716	1,1,1-TRICHLOROETHANE	1	0	<0.05	<0.05	?	?
716	CARBON TETRACHLORIDE	1	0	<0.05	<0.05	?	?
716	BROMODICHLOROMETHANE	1	1	?	?	?	?
716	TRICHLOROETHYLENE	1	1	?	?	?	?
716	DIBROMOCHLOROMETHANE	1	0	<0.10	<0.10	?	?
716	TETRACHLOROETHYLENE	1	1	?	?	?	?
716	BROMOFORM	1	0	<0.20	<0.20	?	?

WATER FACTORY 21
SUMMARY DATA FOR CLSA CONSTITUENTS
FOR PERIOD FROM 1MAR78 TO 9APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	ETHYL BENZENE	99	78	<0.01 - 0.58	0.04	3.52	0.03 - 0.05
001	P-XYLENE	100	55	<0.01 - 0.75	0.01	5.00	0.01 - 0.02
001	M-XYLENE	101	85	<0.01 - 2.93	0.05	3.95	0.04 - 0.07
001	CHLOROBENZENE	110	103	<0.01 - 3.06	0.13	3.09	0.10 - 0.16
001	HEPTALDEHYDE	92	60	<0.01 - 2.00	0.06	4.78	0.04 - 0.09
001	STYRENE	86	61	<0.01 - 1.09	0.04	5.16	0.03 - 0.06
001	1,3-DICHLOROBENZENE	108	105	<0.01 - 5.37	0.25	2.29	0.21 - 0.29
001	1,4-DICHLOROBENZENE	109	109	0.56 - 14.70	1.88	1.64	1.72 - 2.06
001	1,2-DICHLOROBENZENE	110	109	<0.01 - 13.30	0.74	2.65	0.61 - 0.89
001	1,2,4-TRICHLOROBENZENE	110	98	<0.01 - 3.07	0.31	2.85	0.25 - 0.38
001	NAPTHALENE	109	87	<0.01 - 2.46	0.11	4.39	0.08 - 0.16
001	2-METHYL NAPTHALENE	104	53	<0.01 - 0.24	0.02	3.55	0.01 - 0.03
001	1-METHYL NAPTHALENE	105	41	<0.01 - 0.89	0.01	5.40	0.01 - 0.02
001	HEPTYLCYANIDE	89	13	<0.01 - 1.55	0.00	20.22	0.00 - 0.01
002	ETHYL BENZENE	41	39	<0.01 - 0.60	0.07	2.89	0.05 - 0.10
002	P-XYLENE	41	35	<0.01 - 0.27	0.04	2.76	0.03 - 0.05
002	M-XYLENE	41	40	<0.01 - 1.21	0.12	2.99	0.08 - 0.17
002	CHLOROBENZENE	43	42	<0.01 - 1.23	0.15	2.87	0.11 - 0.21
002	HEPTALDEHYDE	42	26	<0.01 - 0.47	0.04	3.44	0.02 - 0.06
002	STYRENE	44	35	<0.01 - 0.59	0.04	3.61	0.03 - 0.07
002	1,3-DICHLOROBENZENE	45	44	<0.01 - 1.20	0.18	2.02	0.15 - 0.22
002	1,4-DICHLOROBENZENE	45	45	0.41 - 4.50	1.36	1.59	1.19 - 1.56
002	1,2-DICHLOROBENZENE	45	45	0.09 - 4.18	0.58	2.44	0.45 - 0.75
002	1,2,4-TRICHLOROBENZENE	45	40	<0.01 - 1.04	0.24	2.51	0.18 - 0.31
002	NAPTHALENE	45	35	<0.01 - 3.40	0.15	5.02	0.09 - 0.25
002	2-METHYL NAPTHALENE	44	23	<0.01 - 0.24	0.02	4.07	0.01 - 0.03
002	1-METHYL NAPTHALENE	45	25	<0.01 - 0.28	0.02	4.11	0.01 - 0.04
002	HEPTYLCYANIDE	43	7	<0.01 - 0.53	0.01	8.14	0.00 - 0.05
004	ETHYL BENZENE	40	36	<0.01 - 0.21	0.04	1.91	0.04 - 0.05
004	P-XYLENE	41	29	<0.01 - 0.13	0.02	2.17	0.02 - 0.03
004	M-XYLENE	41	39	<0.01 - 0.29	0.07	2.44	0.05 - 0.09
004	CHLOROBENZENE	43	41	<0.01 - 1.22	0.11	2.47	0.08 - 0.14
004	HEPTALDEHYDE	43	22	<0.01 - 0.28	0.02	4.16	0.01 - 0.04
004	STYRENE	43	36	<0.01 - 0.33	0.04	3.16	0.03 - 0.06
004	1,3-DICHLOROBENZENE	44	26	<0.01 - 0.20	0.03	2.78	0.02 - 0.04
004	1,4-DICHLOROBENZENE	45	45	0.05 - 0.70	0.18	1.89	0.15 - 0.22
004	1,2-DICHLOROBENZENE	45	39	<0.01 - 1.06	0.12	3.20	0.08 - 0.17
004	1,2,4-TRICHLOROBENZENE	45	37	<0.01 - 0.66	0.12	2.44	0.09 - 0.16
004	NAPTHALENE	45	39	<0.01 - 1.40	0.19	3.03	0.13 - 0.26
004	2-METHYL NAPTHALENE	43	30	<0.01 - 0.50	0.02	3.75	0.01 - 0.04
004	1-METHYL NAPTHALENE	42	28	<0.01 - 0.56	0.03	3.48	0.02 - 0.05
004	HEPTYLCYANIDE	43	9	<0.01 - 1.65	0.01	10.46	0.00 - 0.03
006	ETHYL BENZENE	54	44	<0.01 - 0.34	0.03	2.28	0.02 - 0.04

WATER FACTORY 21
SUMMARY DATA FOR CLSA CONSTITUENTS
FOR PERIOD FROM 1MAR78 TO 9APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
006	P-XYLENE	54	34	<0.01 - 0.40	0.02	3.49	0.01 - 0.03
006	M-XYLENE	54	52	<0.01 - 0.80	0.07	2.43	0.05 - 0.09
006	CHLOROBENZENE	55	53	<0.01 - 2.24	0.13	2.33	0.10 - 0.16
006	HEPTALDEHYDE	49	40	<0.01 - 0.80	0.12	2.93	0.08 - 0.16
006	STYRENE	48	40	<0.01 - 0.67	0.04	2.50	0.03 - 0.06
006	1,3-DICHLOROBENZENE	56	30	<0.01 - 0.33	0.03	3.38	0.02 - 0.04
006	1,4-DICHLOROBENZENE	55	51	<0.01 - 0.69	0.14	2.10	0.11 - 0.17
006	1,2-DICHLOROBENZENE	55	44	<0.01 - 2.40	0.09	3.80	0.06 - 0.13
006	1,2,4-TRICHLOROBENZENE	55	34	<0.01 - 0.53	0.06	2.86	0.04 - 0.09
006	NAPTHALENE	56	49	<0.01 - 2.10	0.13	4.14	0.08 - 0.19
006	2-METHYL NAPTHALENE	56	32	<0.01 - 0.22	0.02	2.92	0.01 - 0.03
006	1-METHYL NAPTHALENE	56	32	<0.01 - 0.25	0.02	3.21	0.01 - 0.03
006	HEPTYLCYANIDE	51	14	<0.01 - 0.14	0.02	2.40	0.01 - 0.04
008	ETHYL BENZENE	17	15	<0.01 - 0.11	0.03	2.56	0.02 - 0.05
008	P-XYLENE	17	14	<0.01 - 0.54	0.02	4.39	0.01 - 0.04
008	M-XYLENE	17	15	<0.01 - 0.97	0.04	3.57	0.02 - 0.09
008	CHLOROBENZENE	17	16	<0.01 - 0.97	0.05	2.85	0.03 - 0.08
008	HEPTALDEHYDE	17	8	<0.01 - 0.09	0.02	2.45	0.01 - 0.04
008	STYRENE	17	15	<0.01 - 0.16	0.01	2.90	0.01 - 0.03
008	1,3-DICHLOROBENZENE	17	6	<0.01 - 0.07	0.02	2.35	0.01 - 0.04
008	1,4-DICHLOROBENZENE	17	12	<0.01 - 0.06	0.02	1.91	0.01 - 0.03
008	1,2-DICHLOROBENZENE	17	15	<0.01 - 0.13	0.03	2.11	0.02 - 0.05
008	1,2,4-TRICHLOROBENZENE	17	10	<0.01 - 0.10	0.01	3.82	0.01 - 0.04
008	NAPTHALENE	17	17	0.03 - 0.30	0.08	2.01	0.06 - 0.12
008	2-METHYL NAPTHALENE	16	6	<0.01 - 0.04	0.01	2.56	0.00 - 0.03
008	1-METHYL NAPTHALENE	15	5	<0.01 - 0.04	0.01	2.92	0.00 - 0.02
008	HEPTYLCYANIDE	15	1	<0.01	<0.01	?	?
009	ETHYL BENZENE	67	39	<0.01 - 1.60	0.02	4.34	0.01 - 0.03
009	P-XYLENE	67	33	<0.01 - 1.49	0.01	5.05	0.01 - 0.02
009	M-XYLENE	68	42	<0.01 - 3.85	0.03	4.78	0.02 - 0.05
009	CHLOROBENZENE	71	58	<0.01 - 2.85	0.07	3.05	0.05 - 0.09
009	HEPTALDEHYDE	65	28	<0.01 - 0.59	0.03	4.50	0.01 - 0.05
009	STYRENE	64	27	<0.01 - 1.66	0.01	6.22	0.01 - 0.02
009	1,3-DICHLOROBENZENE	71	26	<0.01 - 2.58	0.01	15.86	0.00 - 0.04
009	1,4-DICHLOROBENZENE	71	46	<0.01 - 0.40	0.04	3.18	0.03 - 0.06
009	1,2-DICHLOROBENZENE	71	38	<0.01 - 0.82	0.05	4.07	0.03 - 0.08
009	1,2,4-TRICHLOROBENZENE	70	23	<0.01 - 3.80	0.01	15.15	0.00 - 0.02
009	NAPTHALENE	72	38	<0.01 - 1.15	0.03	4.65	0.02 - 0.05
009	2-METHYL NAPTHALENE	71	17	<0.01 - 0.20	0.00	8.80	0.00 - 0.01
009	1-METHYL NAPTHALENE	71	17	<0.01 - 0.20	0.00	6.85	0.00 - 0.01
009	HEPTYLCYANIDE	63	8	<0.01 - 0.72	0.00	11.81	0.00 - 0.02
21A	ETHYL BENZENE	12	9	<0.01 - 0.46	0.05	2.69	0.02 - 0.11
21A	P-XYLENE	12	7	<0.01 - 0.12	0.02	2.74	0.01 - 0.06
21A	M-XYLENE	12	11	<0.01 - 0.38	0.08	2.64	0.04 - 0.16

WATER FACTORY 21
SUMMARY DATA FOR CLSA CONSTITUENTS
FOR PERIOD FROM 1MAR78 TO 9APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
21A	CHLOROBENZENE	12	11	<0.01 - 0.70	0.14	2.39	0.08 - 0.25
21A	HEPTALDEHYDE	12	8	<0.01 - 0.30	0.18	1.48	0.13 - 0.24
21A	STYRENE	12	6	<0.01 - 0.21	0.02	4.62	0.00 - 0.08
21A	1,3-DICHLOROBENZENE	12	10	<0.01 - 0.24	0.12	1.66	0.08 - 0.17
21A	1,4-DICHLOROBENZENE	12	11	<0.01 - 1.80	1.18	1.40	0.95 - 1.48
21A	1,2-DICHLOROBENZENE	12	10	<0.01 - 1.17	0.46	2.30	0.26 - 0.84
21A	1,2,4-TRICHLOROBENZENE	12	6	<0.01 - 0.18	0.04	2.39	0.02 - 0.10
21A	NAPTHALENE	12	6	<0.01 - 0.39	0.05	4.11	0.01 - 0.21
21A	2-METHYL NAPTHALENE	12	2	<0.01 - 0.04	0.02	1.73	0.00 - 0.09
21A	1-METHYL NAPTHALENE	12	3	<0.01 - 0.04	0.02	1.64	0.01 - 0.04
21A	HEPTYLCYANIDE	12	6	<0.01 - 0.10	0.04	1.76	0.03 - 0.08
21B	ETHYL BENZENE	12	9	<0.01 - 0.33	0.03	3.31	0.01 - 0.07
21B	P-XYLENE	12	7	<0.01 - 0.22	0.02	3.44	0.01 - 0.07
21B	M-XYLENE	12	10	<0.01 - 0.65	0.05	3.86	0.02 - 0.13
21B	CHLOROBENZENE	12	11	<0.01 - 0.35	0.07	2.98	0.03 - 0.15
21B	HEPTALDEHYDE	12	5	<0.01 - 0.13	0.05	1.97	0.02 - 0.12
21B	STYRENE	10	4	<0.01 - 0.08	0.01	3.94	0.00 - 0.07
21B	1,3-DICHLOROBENZENE	12	11	<0.01 - 0.13	0.07	1.83	0.04 - 0.10
21B	1,4-DICHLOROBENZENE	12	12	0.51 - 1.40	0.99	1.32	0.83 - 1.18
21B	1,2-DICHLOROBENZENE	12	11	<0.01 - 0.95	0.38	2.15	0.23 - 0.64
21B	1,2,4-TRICHLOROBENZENE	12	8	<0.01 - 0.30	0.11	2.04	0.06 - 0.19
21B	NAPTHALENE	11	7	<0.01 - 1.40	0.07	6.54	0.01 - 0.36
21B	2-METHYL NAPTHALENE	12	6	<0.01 - 0.05	0.02	1.96	0.01 - 0.04
21B	1-METHYL NAPTHALENE	12	6	<0.01 - 0.08	0.02	2.63	0.01 - 0.05
21B	HEPTYLCYANIDE	12	4	<0.01 - 0.11	0.02	2.91	0.01 - 0.10
22A	ETHYL BENZENE	18	12	<0.01 - 0.35	0.02	4.05	0.01 - 0.04
22A	P-XYLENE	19	5	<0.01 - 0.07	0.01	4.72	0.00 - 0.03
22A	M-XYLENE	19	17	<0.01 - 0.15	0.03	2.35	0.02 - 0.04
22A	CHLOROBENZENE	20	18	<0.01 - 0.12	0.04	1.94	0.03 - 0.06
22A	HEPTALDEHYDE	13	10	<0.01 - 0.07	0.03	1.85	0.02 - 0.05
22A	STYRENE	12	7	<0.01 - 0.20	0.02	5.90	0.00 - 0.07
22A	1,3-DICHLOROBENZENE	20	4	<0.01 - 0.13	0.00	7.67	0.00 - 0.04
22A	1,4-DICHLOROBENZENE	20	9	<0.01 - 0.16	0.03	2.49	0.01 - 0.05
22A	1,2-DICHLOROBENZENE	20	10	<0.01 - 0.24	0.02	3.44	0.01 - 0.04
22A	1,2,4-TRICHLOROBENZENE	19	10	<0.01 - 0.49	0.02	4.12	0.01 - 0.05
22A	NAPTHALENE	20	14	<0.01 - 0.37	0.04	3.66	0.02 - 0.08
22A	2-METHYL NAPTHALENE	20	7	<0.01 - 0.04	0.01	1.77	0.01 - 0.02
22A	1-METHYL NAPTHALENE	20	7	<0.01 - 0.08	0.01	2.97	0.00 - 0.03
22A	HEPTYLCYANIDE	11	1	<0.01	<0.01	?	?
22B	ETHYL BENZENE	58	48	<0.01 - 0.35	0.04	2.53	0.03 - 0.05
22B	P-XYLENE	59	43	<0.01 - 0.31	0.03	3.09	0.02 - 0.04
22B	M-XYLENE	60	55	<0.01 - 0.83	0.07	3.11	0.05 - 0.09
22B	CHLOROBENZENE	61	53	<0.01 - 0.67	0.07	2.83	0.05 - 0.09
22B	HEPTALDEHYDE	52	21	<0.01 - 0.10	0.01	2.85	0.01 - 0.02

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SUMMARY DATA FOR CLSA CONSTITUENTS
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(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
22B	STYRENE	52	44	<0.01 - 0.22	0.03	2.83	0.02 - 0.04
22B	1,3-DICHLOROBENZENE	62	31	<0.01 - 0.16	0.01	2.70	0.01 - 0.02
22B	1,4-DICHLOROBENZENE	63	45	<0.01 - 0.30	0.02	2.47	0.02 - 0.03
22B	1,2-DICHLOROBENZENE	63	42	<0.01 - 0.29	0.03	2.42	0.02 - 0.04
22B	1,2,4-TRICHLOROBENZENE	63	24	<0.01 - 0.24	0.01	3.50	0.01 - 0.02
22B	NAPTHALENE	63	56	<0.01 - 0.46	0.06	2.55	0.05 - 0.08
22B	2-METHYL NAPTHALENE	62	32	<0.01 - 0.13	0.01	2.96	0.01 - 0.02
22B	1-METHYL NAPTHALENE	62	27	<0.01 - 0.19	0.01	4.45	0.00 - 0.01
22B	HEPTYLCYANIDE	51	4	<0.01 - 0.72	0.00	*****	0.00 - 0.01
22C	ETHYL BENZENE	1	1	?	?	?	?
22C	P-XYLENE	1	1	?	?	?	?
22C	M-XYLENE	1	1	?	?	?	?
22C	CHLOROBENZENE	1	1	?	?	?	?
22C	HEPTALDEHYDE	0	0	<0.01	<0.01	?	?
22C	STYRENE	0	0	<0.01	<0.01	?	?
22C	1,3-DICHLOROBENZENE	1	0	<0.01	<0.01	?	?
22C	1,4-DICHLOROBENZENE	1	0	<0.01	<0.01	?	?
22C	1,2-DICHLOROBENZENE	1	1	?	?	?	?
22C	1,2,4-TRICHLOROBENZENE	1	1	?	?	?	?
22C	NAPTHALENE	1	1	?	?	?	?
22C	2-METHYL NAPTHALENE	1	1	?	?	?	?
22C	1-METHYL NAPTHALENE	1	0	<0.01	<0.01	?	?
22C	HEPTYLCYANIDE	0	0	<0.01	<0.01	?	?
22R	ETHYL BENZENE	1	1	?	?	?	?
22R	P-XYLENE	1	1	?	?	?	?
22R	M-XYLENE	1	1	?	?	?	?
22R	CHLOROBENZENE	1	1	?	?	?	?
22R	HEPTALDEHYDE	1	1	?	?	?	?
22R	STYRENE	1	0	<0.01	<0.01	?	?
22R	1,3-DICHLOROBENZENE	1	0	<0.01	<0.01	?	?
22R	1,4-DICHLOROBENZENE	1	1	?	?	?	?
22R	1,2-DICHLOROBENZENE	1	1	?	?	?	?
22R	1,2,4-TRICHLOROBENZENE	1	1	?	?	?	?
22R	NAPTHALENE	1	1	?	?	?	?
22R	2-METHYL NAPTHALENE	1	1	?	?	?	?
22R	1-METHYL NAPTHALENE	1	1	?	?	?	?
22R	HEPTYLCYANIDE	1	0	<0.01	<0.01	?	?
703	ETHYL BENZENE	4	4	0.02 - 0.04	0.03	1.39	0.02 - 0.05
703	P-XYLENE	4	3	<0.01 - 0.03	0.02	1.47	0.01 - 0.04
703	M-XYLENE	4	4	0.02 - 0.05	0.03	1.55	0.02 - 0.06
703	CHLOROBENZENE	4	4	0.02 - 0.13	0.06	2.44	0.02 - 0.22
703	HEPTALDEHYDE	5	4	<0.01 - 0.19	0.04	2.93	0.01 - 0.19
703	STYRENE	4	4	0.02 - 0.15	0.07	2.60	0.02 - 0.25
703	1,3-DICHLOROBENZENE	5	5	0.03 - 0.17	0.07	2.15	0.03 - 0.17

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LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
703	1,4-DICHLOROBENZENE	5	5	0.05 - 0.15	0.08	1.58	0.05 - 0.13
703	1,2-DICHLOROBENZENE	5	5	0.04 - 0.22	0.07	2.31	0.03 - 0.19
703	1,2,4-TRICHLOROBENZENE	5	3	<0.01 - 0.41	0.04	6.35	0.00 - 1.14
703	NAPTHALENE	5	5	0.07 - 1.07	0.14	2.89	0.04 - 0.49
703	2-METHYL NAPTHALENE	5	1	<0.01	<0.01	?	?
703	1-METHYL NAPTHALENE	5	1	<0.01	<0.01	?	?
703	HEPTYLCYANIDE	3	0	<0.01	<0.01	?	?
705	ETHYL BENZENE	16	7	<0.01 - 0.04	0.02	1.70	0.01 - 0.03
705	P-XYLENE	16	4	0.02 - 0.02	0.02	?	?
705	M-XYLENE	16	10	<0.01 - 0.06	0.02	2.06	0.01 - 0.03
705	CHLOROBENZENE	17	16	<0.01 - 0.15	0.07	1.80	0.05 - 0.10
705	HEPTALDEHYDE	15	6	<0.01 - 0.71	0.02	9.63	0.00 - 0.16
705	STYRENE	14	6	<0.01 - 0.23	0.01	5.67	0.00 - 0.05
705	1,3-DICHLOROBENZENE	16	1	<0.01	<0.01	?	?
705	1,4-DICHLOROBENZENE	17	2	<0.01 - 0.08	0.03	1.81	0.00 - 0.17
705	1,2-DICHLOROBENZENE	16	4	<0.01 - 0.15	0.02	3.47	0.00 - 0.10
705	1,2,4-TRICHLOROBENZENE	16	3	<0.01 - 0.14	0.00	12.02	0.00 - 0.16
705	NAPTHALENE	17	4	<0.01 - 0.23	0.00	12.26	0.00 - 0.08
705	2-METHYL NAPTHALENE	17	1	<0.01	<0.01	?	?
705	1-METHYL NAPTHALENE	16	1	<0.01	<0.01	?	?
705	HEPTYLCYANIDE	16	1	<0.01	<0.01	?	?
711	ETHYL BENZENE	1	0	<0.01	<0.01	?	?
711	P-XYLENE	1	0	<0.01	<0.01	?	?
711	M-XYLENE	1	0	<0.01	<0.01	?	?
711	CHLOROBENZENE	1	1	?	?	?	?
711	HEPTALDEHYDE	0	0	<0.01	<0.01	?	?
711	STYRENE	0	0	<0.01	<0.01	?	?
711	1,3-DICHLOROBENZENE	1	0	<0.01	<0.01	?	?
711	1,4-DICHLOROBENZENE	1	0	<0.01	<0.01	?	?
711	1,2-DICHLOROBENZENE	1	0	<0.01	<0.01	?	?
711	1,2,4-TRICHLOROBENZENE	1	1	?	?	?	?
711	NAPTHALENE	1	0	<0.01	<0.01	?	?
711	2-METHYL NAPTHALENE	1	0	<0.01	<0.01	?	?
711	1-METHYL NAPTHALENE	1	0	<0.01	<0.01	?	?
711	HEPTYLCYANIDE	0	0	<0.01	<0.01	?	?
712	ETHYL BENZENE	11	7	<0.01 - 0.18	0.02	3.02	0.01 - 0.06
712	P-XYLENE	11	4	<0.01 - 0.10	0.01	4.31	0.00 - 0.07
712	M-XYLENE	11	8	<0.01 - 0.39	0.03	3.96	0.01 - 0.10
712	CHLOROBENZENE	12	10	<0.01 - 0.34	0.05	3.08	0.02 - 0.10
712	HEPTALDEHYDE	12	2	<0.01 - 0.12	0.01	5.31	0.00 - 1.25
712	STYRENE	11	3	<0.01 - 0.04	0.01	2.64	0.00 - 0.05
712	1,3-DICHLOROBENZENE	12	0	<0.01	<0.01	?	?
712	1,4-DICHLOROBENZENE	12	4	<0.01 - 0.14	0.01	7.29	0.00 - 0.09
712	1,2-DICHLOROBENZENE	12	1	<0.01	<0.01	?	?

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SUMMARY DATA FOR CLSA CONSTITUENTS
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(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
712	1,2,4-TRICHLOROBENZENE	12	2	<0.01 - 0.05	0.00	5.74	0.00 - 0.58
712	NAPTHALENE	11	2	<0.01 - 0.06	0.00	7.77	0.00 - 1.16
712	2-METHYL NAPTHALENE	12	1	<0.01	<0.01	?	?
712	1-METHYL NAPTHALENE	12	2	<0.01 - 0.10	0.00	21.53	0.00 - 7.43
712	HEPTYLCYANIDE	12	2	<0.01 - 0.13	0.01	6.19	0.00 - 1.68
715	ETHYL BENZENE	2	0	<0.01	<0.01	?	?
715	P-XYLENE	2	1	<0.01	<0.01	?	?
715	M-XYLENE	2	0	<0.01	<0.01	?	?
715	CHLOROBENZENE	2	2	0.03 - 0.04	0.03	1.28	0.02 - 0.07
715	HEPTALDEHYDE	0	0	<0.01	<0.01	?	?
715	STYRENE	0	0	<0.01	<0.01	?	?
715	1,3-DICHLOROBENZENE	2	0	<0.01	<0.01	?	?
715	1,4-DICHLOROBENZENE	2	1	<0.01	<0.01	?	?
715	1,2-DICHLOROBENZENE	2	0	<0.01	<0.01	?	?
715	1,2,4-TRICHLOROBENZENE	2	0	<0.01	<0.01	?	?
715	NAPTHALENE	2	1	<0.01	<0.01	?	?
715	2-METHYL NAPTHALENE	2	0	<0.01	<0.01	?	?
715	1-METHYL NAPTHALENE	2	0	<0.01	<0.01	?	?
715	HEPTYLCYANIDE	0	0	<0.01	<0.01	?	?
716	ETHYL BENZENE	2	1	<0.01	<0.01	?	?
716	P-XYLENE	2	0	<0.01	<0.01	?	?
716	M-XYLENE	2	0	<0.01	<0.01	?	?
716	CHLOROBENZENE	2	2	0.02 - 0.11	0.05	4.27	0.00 - 3.87
716	HEPTALDEHYDE	1	0	<0.01	<0.01	?	?
716	STYRENE	1	0	<0.01	<0.01	?	?
716	1,3-DICHLOROBENZENE	2	0	<0.01	<0.01	?	?
716	1,4-DICHLOROBENZENE	2	0	<0.01	<0.01	?	?
716	1,2-DICHLOROBENZENE	2	0	<0.01	<0.01	?	?
716	1,2,4-TRICHLOROBENZENE	2	0	<0.01	<0.01	?	?
716	NAPTHALENE	2	1	<0.01	<0.01	?	?
716	2-METHYL NAPTHALENE	2	0	<0.01	<0.01	?	?
716	1-METHYL NAPTHALENE	2	0	<0.01	<0.01	?	?
716	HEPTYLCYANIDE	1	0	<0.01	<0.01	?	?

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LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	AROCLOR 1 2 4 2	86	57	<0.05 - 2.40	0.40	2.27	0.32 - 0.49
001	DIMETHYLPHTHALATE	82	61	<0.30 - *****	2.55	5.42	1.67 - 3.90
001	DIETHYLPHTHALATE	86	45	<0.30 - 78.60	0.63	15.50	0.28 - 1.41
001	DI-ISOBUTYLPHTHALATE	86	75	<0.30 - 31.00	3.40	2.36	2.80 - 4.13
001	DI-N-BUTYLPHTHALATE	84	31	<0.50 - 12.16	0.34	3.76	0.21 - 0.54
001	DIETHYLHEXYLPHTHALATE	82	52	<4.00 - 75.00	6.85	3.07	5.05 - 9.29
001	LINDANE	86	77	<0.05 - 0.46	0.11	1.55	0.10 - 0.12
001	DDT	86	8	<0.05 = 0.45	0.00	7.74	0.00 = 0.02
001	2,4,6 TCA	41	1	<0.30	<0.30	?	?
001	2,3,4,5 TECA	41	0	<0.30	<0.30	?	?
001	2,3,5,6 TECA	41	3	<0.30 - 0.53	0.14	1.83	0.05 - 0.43
001	PCA	50	33	<0.30 - 2.41	0.56	2.46	0.41 - 0.77
002	AROCLOR 1 2 4 2	34	10	<0.05 - 0.70	0.25	1.80	0.17 - 0.38
002	DIMETHYLPHTHALATE	34	21	<0.30 - 15.40	2.28	3.46	1.30 - 4.00
002	DIETHYLPHTHALATE	34	18	<0.30 - 58.64	2.27	9.01	0.77 - 6.75
002	DI-ISOBUTYLPHTHALATE	34	33	<0.30 - 15.00	2.94	1.93	2.35 - 3.68
002	DI-N-BUTYLPHTHALATE	32	6	<0.50 - 6.10	0.08	7.75	0.01 - 0.63
002	DIETHYLHEXYLPHTHALATE	34	9	<4.00 - 23.60	1.64	3.43	0.65 - 4.14
002	LINDANE	32	3	<0.05 - 0.15	0.01	5.11	0.00 - 0.10
002	DDT	34	0	<0.05	<0.05	?	?
002	2,4,6 TCA	22	1	<0.30	<0.30	?	?
002	2,3,4,5 TECA	22	0	<0.30	<0.30	?	?
002	2,3,5,6 TECA	22	0	<0.30	<0.30	?	?
002	PCA	23	14	<0.30 - 1.40	0.35	2.47	0.21 - 0.58
004	AROCLOR 1 2 4 2	35	2	<0.05 - 0.60	0.24	1.54	0.06 - 0.90
004	DIMETHYLPHTHALATE	34	21	<0.30 - 40.23	2.24	4.64	1.11 - 4.48
004	DIETHYLPHTHALATE	35	19	<0.30 - 52.73	0.97	13.77	0.28 - 3.41
004	DI-ISOBUTYLPHTHALATE	35	33	<0.30 - 16.39	2.45	2.20	1.87 - 3.20
004	DI-N-BUTYLPHTHALATE	34	7	<0.50 - 3.70	0.24	3.91	0.07 - 0.81
004	DIETHYLHEXYLPHTHALATE	34	8	<4.00 - 11.31	2.11	2.40	1.04 - 4.31
004	LINDANE	31	4	<0.05 - 0.32	0.00	8.12	0.00 - 0.09
004	DDT	35	1	<0.05	<0.05	?	?
004	2,4,6 TCA	23	0	<0.30	<0.30	?	?
004	2,3,4,5 TECA	24	0	<0.30	<0.30	?	?
004	2,3,5,6 TECA	24	0	<0.30	<0.30	?	?
004	PCA	25	12	<0.30 - 1.62	0.27	2.37	0.16 - 0.47
006	AROCLOR 1 2 4 2	41	6	<0.05 - 3.00	0.00	20.65	0.00 - 0.09
006	DIMETHYLPHTHALATE	41	34	<0.30 - *****	2.04	5.14	1.18 - 3.55
006	DIETHYLPHTHALATE	41	21	<0.30 - 37.53	0.38	13.94	0.11 - 1.24
006	DI-ISOBUTYLPHTHALATE	41	37	<0.30 - 7.40	1.63	1.94	1.32 - 2.02
006	DI-N-BUTYLPHTHALATE	39	9	<0.50 - 10.47	0.10	8.40	0.02 - 0.49
006	DIETHYLHEXYLPHTHALATE	41	13	<4.00 - 11.09	3.25	1.77	2.31 - 4.57
006	LINDANE	41	22	<0.05 - 0.17	0.06	1.75	0.04 - 0.07

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LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
006	DDT	40	1	<0.05	<0.05	?	?
006	2,4,6 TCA	21	0	<0.30	<0.30	?	?
006	2,3,4,5 TECA	22	0	<0.30	<0.30	?	?
006	2,3,5,6 TECA	22	0	<0.30	<0.30	?	?
006	PCA	26	8	<0.30 - 0.78	0.20	1.93	0.12 - 0.34
008	AROCLOR 1 2 4 2	9	0	<0.05	<0.05	?	?
008	DIMETHYLPHTHALATE	9	5	<0.30 - 9.84	1.28	4.41	0.23 - 7.03
008	DIETHYLPHTHALATE	9	0	<0.30	<0.30	?	?
008	DI-ISOBUTYLPHTHALATE	9	0	<0.30	<0.30	?	?
008	DI-N-BUTYLPHTHALATE	9	1	<0.50	<0.50	?	?
008	DIETHYLHEXYLPHTHALATE	9	1	<4.00	<4.00	?	?
008	LINDANE	9	0	<0.05	<0.05	?	?
008	DDT	9	0	<0.05	<0.05	?	?
008	2,4,6 TCA	9	0	<0.30	<0.30	?	?
008	2,3,4,5 TECA	9	0	<0.30	<0.30	?	?
008	2,3,5,6 TECA	9	0	<0.30	<0.30	?	?
008	PCA	9	0	<0.30	<0.30	?	?
009	AROCLOR 1 2 4 2	54	1	<0.05	<0.05	?	?
009	DIMETHYLPHTHALATE	50	27	<0.30 - 24.18	0.40	7.51	0.18 - 0.89
009	DIETHYLPHTHALATE	54	2	<0.30 - 1.00	0.02	5.94	0.00 - 3.92
009	DI-ISOBUTYLPHTHALATE	53	18	<0.30 - 9.06	0.14	6.96	0.05 - 0.36
009	DI-N-BUTYLPHTHALATE	53	9	<0.50 - 4.10	0.14	4.92	0.04 - 0.48
009	DIETHYLHEXYLPHTHALATE	52	11	<4.00 - 67.56	0.48	10.50	0.10 - 2.27
009	LINDANE	54	0	<0.05	<0.05	?	?
009	DDT	54	0	<0.05	<0.05	?	?
009	2,4,6 TCA	17	0	<0.30	<0.30	?	?
009	2,3,4,5 TECA	22	0	<0.30	<0.30	?	?
009	2,3,5,6 TECA	22	0	<0.30	<0.30	?	?
009	PCA	27	1	<0.30	<0.30	?	?
21A	AROCLOR 1 2 4 2	12	8	<0.05 - 0.60	0.35	1.48	0.25 - 0.48
21A	DIMETHYLPHTHALATE	12	12	0.60 - 4.10	1.30	1.72	0.92 - 1.82
21A	DIETHYLPHTHALATE	11	7	<0.30 - 1.60	0.45	2.17	0.23 - 0.90
21A	DI-ISOBUTYLPHTHALATE	12	12	1.50 - 4.40	2.86	1.38	2.33 - 3.50
21A	DI-N-BUTYLPHTHALATE	11	4	<0.50 - 4.50	1.01	2.42	0.30 - 3.47
21A	DIETHYLHEXYLPHTHALATE	12	0	<4.00	<4.00	?	?
21A	LINDANE	12	7	<0.05 - 0.12	0.07	1.44	0.05 - 0.10
21A	DDT	12	0	<0.05	<0.05	?	?
21A	2,4,6 TCA	0	0	<0.30	<0.30	?	?
21A	2,3,4,5 TECA	0	0	<0.30	<0.30	?	?
21A	2,3,5,6 TECA	0	0	<0.30	<0.30	?	?
21A	PCA	0	0	<0.30	<0.30	?	?
21B	AROCLOR 1 2 4 2	12	2	0.30 - 0.30	0.30	?	?
21B	DIMETHYLPHTHALATE	11	10	<0.30 - 5.10	1.04	2.18	0.60 - 1.80

WATER FACTORY 21
SUMMARY DATA FOR SEA CONSTITUENTS
FOR PERIOD FROM 1MAR78 TO 1APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
21B	DIETHYLPHTHALATE	12	7	<0.30 - 1.70	0.46	2.15	0.23 - 0.90
21B	DI-ISOBUTYLPHTHALATE	11	11	1.50 - 4.60	2.38	1.53	1.80 - 3.15
21B	DI-N-BUTYLPHTHALATE	12	7	<0.50 - 2.80	0.72	2.42	0.33 - 1.59
21B	DIETHYLHEXYLPHTHALATE	12	1	<4.00	<4.00	?	?
21B	LINDANE	12	6	<0.05 - 0.08	0.07	1.13	0.06 - 0.07
21B	DDT	12	0	<0.05	<0.05	?	?
21B	2,4,6 TCA	0	0	<0.30	<0.30	?	?
21B	2,3,4,5 TECA	0	0	<0.30	<0.30	?	?
21B	2,3,5,6 TECA	0	0	<0.30	<0.30	?	?
21B	PCA	0	0	<0.30	<0.30	?	?
22A	AROCLOR 1 2 4 2	9	0	<0.05	<0.05	?	?
22A	DIMETHYLPHTHALATE	9	9	1.10 - 10.00	2.39	2.07	1.38 - 4.13
22A	DIETHYLPHTHALATE	9	2	<0.30 - 2.10	0.07	9.46	0.00 -67.63
22A	DI-ISOBUTYLPHTHALATE	9	3	<0.30 - 0.83	0.28	2.04	0.08 - 1.05
22A	DI-N-BUTYLPHTHALATE	9	5	<0.50 - 4.90	0.60	4.26	0.11 - 3.15
22A	DIETHYLHEXYLPHTHALATE	9	5	<4.00 - 63.00	4.94	4.85	0.80 -30.32
22A	LINDANE	9	0	<0.05	<0.05	?	?
22A	DDT	9	0	<0.05	<0.05	?	?
22A	2,4,6 TCA	1	0	<0.30	<0.30	?	?
22A	2,3,4,5 TECA	1	0	<0.30	<0.30	?	?
22A	2,3,5,6 TECA	1	0	<0.30	<0.30	?	?
22A	PCA	2	0	<0.30	<0.30	?	?
22B	AROCLOR 1 2 4 2	37	0	<0.05	<0.05	?	?
22B	DIMETHYLPHTHALATE	36	18	<0.30 - 10.91	0.32	5.71	0.14 - 0.77
22B	DIETHYLPHTHALATE	37	5	<0.30 - 2.66	0.63	2.00	0.28 - 1.39
22B	DI-ISOBUTYLPHTHALATE	37	8	<0.30 - 6.90	0.05	10.13	0.01 - 0.32
22B	DI-N-BUTYLPHTHALATE	36	10	<0.50 - 3.40	0.29	3.39	0.12 - 0.69
22B	DIETHYLHEXYLPHTHALATE	36	13	<4.00 - 37.87	2.09	3.76	0.95 - 4.62
22B	LINDANE	35	0	<0.05	<0.05	?	?
22B	DDT	37	0	<0.05	<0.05	?	?
22B	2,4,6 TCA	23	0	<0.30	<0.30	?	?
22B	2,3,4,5 TECA	23	0	<0.30	<0.30	?	?
22B	2,3,5,6 TECA	22	0	<0.30	<0.30	?	?
22B	PCA	24	0	<0.30	<0.30	?	?
22R	AROCLOR 1 2 4 2	1	0	<0.05	<0.05	?	?
22R	DIMETHYLPHTHALATE	1	1	?	?	?	?
22R	DIETHYLPHTHALATE	1	1	?	?	?	?
22R	DI-ISOBUTYLPHTHALATE	0	0	<0.30	<0.30	?	?
22R	DI-N-BUTYLPHTHALATE	1	0	<0.50	<0.50	?	?
22R	DIETHYLHEXYLPHTHALATE	1	0	<4.00	<4.00	?	?
22R	LINDANE	1	0	<0.05	<0.05	?	?
22R	DDT	1	0	<0.05	<0.05	?	?
22R	2,4,6 TCA	1	0	<0.30	<0.30	?	?
22R	2,3,4,5 TECA	1	0	<0.30	<0.30	?	?

WATER FACTORY 21
SUMMARY DATA FOR SEA CONSTITUENTS
FOR PERIOD FROM 1MAR78 TO 1AFR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
22R	2,3,5,6 TECA	1	0	<0.30	<0.30	?	?
22R	PCA	1	0	<0.30	<0.30	?	?
703	AROCLOR 1 2 4 2	1	0	<0.05	<0.05	?	?
703	DIMETHYLPHTHALATE	1	1	?	?	?	?
703	DIETHYLPHTHALATE	1	0	<0.30	<0.30	?	?
703	DI-ISOBUTYLPHTHALATE	1	0	<0.30	<0.30	?	?
703	DI-N-BUTYLPHTHALATE	1	0	<0.50	<0.50	?	?
703	DIETHYLHEXYLPHTHALATE	1	0	<4.00	<4.00	?	?
703	LINDANE	1	0	<0.05	<0.05	?	?
703	DDT	1	0	<0.05	<0.05	?	?
703	2,4,6 TCA	1	0	<0.30	<0.30	?	?
703	2,3,4,5 TECA	1	0	<0.30	<0.30	?	?
703	2,3,5,6 TECA	1	0	<0.30	<0.30	?	?
703	PCA	1	0	<0.30	<0.30	?	?
705	AROCLOR 1 2 4 2	15	0	<0.05	<0.05	?	?
705	DIMETHYLPHTHALATE	12	9	<0.30 - 3.80	1.72	1.83	1.09 - 2.70
705	DIETHYLPHTHALATE	15	4	<0.30 - 1.20	0.51	1.66	0.25 - 1.02
705	DI-ISOBUTYLPHTHALATE	15	5	<0.30 - 1.00	0.30	2.10	0.13 - 0.69
705	DI-N-BUTYLPHTHALATE	14	5	<0.50 - 2.20	0.49	2.45	0.17 - 1.36
705	DIETHYLHEXYLPHTHALATE	15	5	<4.00 - 6.40	4.83	1.21	3.89 - 6.01
705	LINDANE	15	0	<0.05	<0.05	?	?
705	DDT	15	0	<0.05	<0.05	?	?
705	2,4,6 TCA	0	0	<0.30	<0.30	?	?
705	2,3,4.5 TECA	0	0	<0.30	<0.30	?	?
705	2,3,5,6 TECA	0	0	<0.30	<0.30	?	?
705	PCA	0	0	<0.30	<0.30	?	?
712	AROCLOR 1 2 4 2	14	0	<0.05	<0.05	?	?
712	DIMETHYLPHTHALATE	14	8	<0.30 - 4.70	0.52	3.26	0.20 - 1.35
712	DIETHYLPHTHALATE	14	2	<0.30 - 1.20	0.19	2.90	0.01 - 4.96
712	DI-ISOBUTYLPHTHALATE	14	2	<0.30 - 1.60	0.33	2.53	0.02 - 5.51
712	DI-N-BUTYLPHTHALATE	14	5	<0.50 - 3.70	0.46	3.39	0.11 - 1.86
712	DIETHYLHEXYLPHTHALATE	14	6	<4.00 - 14.00	3.03	2.46	1.23 - 7.47
712	LINDANE	14	0	<0.05	<0.05	?	?
712	DDT	14	0	<0.05	<0.05	?	?
712	2,4,6 TCA	0	0	<0.30	<0.30	?	?
712	2,3,4,5 TECA	0	0	<0.30	<0.30	?	?
712	2,3,5,6 TECA	0	0	<0.30	<0.30	?	?
712	PCA	1	0	<0.30	<0.30	?	?
715	AROCLOR 1 2 4 2	1	0	<0.05	<0.05	?	?
715	DIMETHYLPHTHALATE	0	0	<0.30	<0.30	?	?
715	DIETHYLPHTHALATE	1	0	<0.30	<0.30	?	?
715	DI-ISOBUTYLPHTHALATE	1	1	?	?	?	?
715	DI-N-BUTYLPHTHALATE	1	0	<0.50	<0.50	?	?

WATER FACTORY 21
SUMMARY DATA FOR SEA CONSTITUENTS
FOR PERIOD FROM 1MAR78 TO 1APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
715	DIETHYLHEXYLPHTHALATE	1	0	<4.00	<4.00	?	?
715	LINDANE	1	0	<0.05	<0.05	?	?
715	DDT	1	0	<0.05	<0.05	?	?
715	2,4,6 TCA	0	0	<0.30	<0.30	?	?
715	2,3,4,5 TECA	0	0	<0.30	<0.30	?	?
715	2,3,5,6 TECA	0	0	<0.30	<0.30	?	?
715	PCA	0	0	<0.30	<0.30	?	?
716	AROCLOR 1 2 4 2	1	0	<0.05	<0.05	?	?
716	DIMETHYLPHTHALATE	1	1	?	?	?	?
716	DIETHYLPHTHALATE	1	1	?	?	?	?
716	DI-ISOBUTYLPHTHALATE	1	1	?	?	?	?
716	DI-N-BUTYLPHTHALATE	1	1	?	?	?	?
716	DIETHYLHEXYLPHTHALATE	1	0	<4.00	<4.00	?	?
716	LINDANE	1	0	<0.05	<0.05	?	?
716	DDT	1	0	<0.05	<0.05	?	?
716	2,4,6 TCA	0	0	<0.30	<0.30	?	?
716	2,3,4,5 TECA	0	0	<0.30	<0.30	?	?
716	2,3,5,6 TECA	0	0	<0.30	<0.30	?	?
716	PCA	0	0	<0.30	<0.30	?	?

APPENDIX D

SUMMARY DATA FOR PERIOD JANUARY 1980 TO APRIL 1981

Location Designation	Description		
001	Q1	-	Plant influent
002	Q2	-	Chemical effluent
003	Q3	-	Between air stripping towers
004	Q4	-	Stripping tower effluent
006	Q6	-	Recarbonation basin effuent
007X	Q7X	-	Effluents from individual GAC columns
008	Q8	-	GAC effluent - influent to final chlorination basin
009	Q9	-	Final chlorination effluent
010	Q10	-	Combined effluents for injection
21A	Q21A	-	Influent to experimental RO plant - special study
21B	Q21B	-	Effluent from experimental RO plant - special study
22A	Q22A	-	GAC effluent - influent to RO
22B	Q22B	-	RO effluent - after decarbonation
22C	Q22C	-	RO effluent - prior to decarbonation

WATER FACTORY 21
SUMMARY DATA FOR GENERAL PARAMETERS FILE 1
FOR PERIOD FROM 1JAN80 TO 1APR81
(CONCENTRATIONS FOR CYANIDE AND PHENOL IN UG/L, ALL OTHERS IN MG/L)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	TOTAL DISS.SOLIDS	60	60	909.00 -1290.00	1066.64	1.08	1045.17 -1088.55
001	TOTAL HARDNESS	27	27	240.00 - 360.00	298.01	1.10	287.41 - 309.00
001	MAGNESIUM	61	61	13.00 - 37.00	24.47	1.22	23.27 - 25.74
001	SODIUM	28	28	190.00 - 260.00	231.93	1.09	224.39 - 239.72
001	POTASSIUM	26	26	8.40 - 58.00	14.27	1.34	12.68 - 16.05
001	BORON	61	61	0.50 - 1.10	0.85	1.17	0.82 - 0.88
001	PHOSPHATE	59	59	3.30 - 7.40	5.59	1.18	5.35 - 5.83
001	CYANIDE	50	50	2.90 - 220.00	33.43	2.30	26.53 - 42.14
001	METH. BLUE ACTIVE SUBS	27	27	0.10 - 0.58	0.24	1.59	0.20 - 0.29
001	PHENOL	28	28	3.10 - 22.00	11.80	1.60	9.85 - 14.14
001	AMMONIA NITROGEN	85	85	10.36 - 67.76	27.19	1.32	25.61 - 28.86
001	ORGANIC NITROGEN	44	35	< 0.10 - 7.40	1.87	2.08	1.47 - 2.39
001	TOT KJELDAHL NITROGEN	44	44	21.00 - 62.00	31.26	1.23	29.38 - 33.26
001	NITRATE NITROGEN	53	31	< 0.10 - 1.70	0.07	3.02	0.05 - 0.10
001	FREE CHLORINE RESIDUAL	0	0	< 0.10	< 0.10	?	?
001	TOTAL CHLORINE RESID.	0	0	< 0.10	< 0.10	?	?
002	TOTAL DISS.SOLIDS	56	56	810.00 -1370.00	1005.80	1.12	977.19 -1035.25
002	TOTAL HARDNESS	24	24	180.00 - 510.00	240.03	1.29	215.70 - 267.10
002	MAGNESIUM	58	54	< 0.10 - 20.00	1.78	3.75	1.25 - 2.53
002	SODIUM	25	25	200.00 - 270.00	230.63	1.09	222.31 - 239.27
002	POTASSIUM	25	25	8.50 - 58.00	14.42	1.33	12.83 - 16.20
002	BORON	58	58	0.50 - 0.90	0.63	1.19	0.60 - 0.65
002	PHOSPHATE	55	11	< 0.10 - 0.40	0.02	3.76	0.01 - 0.06
002	CYANIDE	47	47	8.80 - 92.00	29.17	1.76	24.81 - 34.28
002	METH. BLUE ACTIVE SUBS	23	23	0.14 - 0.55	0.27	1.57	0.22 - 0.33
002	PHENOL	24	24	3.70 - 82.00	13.79	1.83	10.71 - 17.76
002	AMMONIA NITROGEN	91	91	11.50 - 68.00	26.90	1.32	25.41 - 28.47
002	ORGANIC NITROGEN	44	35	< 0.10 - 6.30	0.82	2.62	0.59 - 1.12
002	TOT KJELDAHL NITROGEN	44	44	3.80 - 70.00	29.30	1.36	26.77 - 32.06
002	NITRATE NITROGEN	24	12	< 0.10 - 1.00	0.07	3.72	0.03 - 0.16
002	FREE CHLORINE RESIDUAL	0	0	< 0.10	< 0.10	?	?
002	TOTAL CHLORINE RESID.	0	0	< 0.10	< 0.10	?	?
003	TOTAL DISS.SOLIDS	0	0	< 1.00	< 1.00	?	?
003	TOTAL HARDNESS	0	0	< 1.00	< 1.00	?	?
003	MAGNESIUM	0	0	< 0.10	< 0.10	?	?
003	SODIUM	0	0	< 0.10	< 0.10	?	?
003	POTASSIUM	0	0	< 0.10	< 0.10	?	?
003	BORON	0	0	< 0.10	< 0.10	?	?
003	PHOSPHATE	0	0	< 0.10	< 0.10	?	?
003	CYANIDE	0	0	< 0.10	< 0.10	?	?
003	METH. BLUE ACTIVE SUBS	0	0	< 0.10	< 0.10	?	?
003	PHENOL	0	0	< 1.00	< 1.00	?	?
003	AMMONIA NITROGEN	24	24	10.92 - 67.20	22.22	1.48	18.83 - 26.22
003	ORGANIC NITROGEN	5	5	1.30 - 2.80	1.85	1.40	1.26 - 2.72

WATER FACTORY 21
SUMMARY DATA FOR GENERAL PARAMETERS FILE 1
FOR PERIOD FROM 1JAN80 TO 1APR81
(CONCENTRATIONS FOR CYANIDE AND PHENOL IN UG/L, ALL OTHERS IN MG/L)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
003	TOT KJELDAHL NITROGEN	5	5	23.00 - 35.00	28.47	1.20	23.05 - 35.18
003	NITRATE NITROGEN	0	0	< 0.10	< 0.10	?	?
003	FREE CHLORINE RESIDUAL	0	0	< 0.10	< 0.10	?	?
003	TOTAL CHLORINE RESID.	0	0	< 0.10	< 0.10	?	?
004	TOTAL DISS.SOLIDS	24	24	854.00 -1624.00	1014.80	1.16	953.81 -1079.69
004	TOTAL HARDNESS	24	24	104.00 - 540.00	219.73	1.41	190.06 - 254.02
004	MAGNESIUM	24	22	< 0.10 - 8.80	1.15	4.96	0.57 - 2.33
004	SODIUM	24	24	150.00 - 260.00	223.93	1.10	214.86 - 233.38
004	POTASSIUM	24	24	8.50 - 50.00	14.37	1.34	12.70 - 16.26
004	BORON	24	24	0.50 - 1.00	0.67	1.21	0.62 - 0.72
004	PHOSPHATE	24	1	< 0.10	< 0.10	?	?
004	CYANIDE	23	23	0.45 - 77.00	27.68	2.58	18.40 - 41.65
004	METH. BLUE ACTIVE SUBS	21	21	0.10 - 0.80	0.29	1.69	0.23 - 0.37
004	PHENOL	25	25	2.40 - 25.00	6.64	1.67	5.37 - 8.20
004	AMMONIA NITROGEN	74	74	10.92 - 66.00	24.94	1.32	23.42 - 26.55
004	ORGANIC NITROGEN	42	33	< 0.10 - 6.00	0.74	2.61	0.53 - 1.02
004	TOT KJELDAHL NITROGEN	43	43	0.80 - 67.00	24.34	1.65	20.97 - 28.26
004	NITRATE NITROGEN	21	21	0.20 - 1.60	0.58	1.75	0.45 - 0.74
004	FREE CHLORINE RESIDUAL	0	0	< 0.10	< 0.10	?	?
004	TOTAL CHLORINE RESID.	0	0	< 0.10	< 0.10	?	?
005	TOTAL DISS.SOLIDS	0	0	< 1.00	< 1.00	?	?
005	TOTAL HARDNESS	0	0	< 1.00	< 1.00	?	?
005	MAGNESIUM	0	0	< 0.10	< 0.10	?	?
005	SODIUM	0	0	< 0.10	< 0.10	?	?
005	POTASSIUM	0	0	< 0.10	< 0.10	?	?
005	BORON	0	0	< 0.10	< 0.10	?	?
005	PHOSPHATE	0	0	< 0.10	< 0.10	?	?
005	CYANIDE	0	0	< 0.10	< 0.10	?	?
005	METH. BLUE ACTIVE SUBS	0	0	< 0.10	< 0.10	?	?
005	PHENOL	0	0	< 1.00	< 1.00	?	?
005	AMMONIA NITROGEN	17	17	11.76 - 26.18	16.90	1.25	15.07 - 18.96
005	ORGANIC NITROGEN	0	0	< 0.10	< 0.10	?	?
005	TOT KJELDAHL NITROGEN	0	0	< 0.10	< 0.10	?	?
005	NITRATE NITROGEN	0	0	< 0.10	< 0.10	?	?
005	FREE CHLORINE RESIDUAL	0	0	< 0.10	< 0.10	?	?
005	TOTAL CHLORINE RESID.	0	0	< 0.10	< 0.10	?	?
006	TOTAL DISS.SOLIDS	26	26	838.00 -1250.00	997.51	1.13	950.88 -1046.44
006	TOTAL HARDNESS	25	25	170.00 - 380.00	224.98	1.23	206.44 - 245.18
006	MAGNESIUM	26	25	< 0.10 - 7.60	2.14	2.62	1.44 - 3.18
006	SODIUM	26	26	190.00 - 260.00	224.79	1.08	217.73 - 232.07
006	POTASSIUM	26	26	8.50 - 56.00	14.08	1.34	12.51 - 15.85
006	BORON	26	26	0.40 - 0.80	0.63	1.18	0.59 - 0.68
006	PHOSPHATE	26	1	< 0.10	< 0.10	?	?
006	CYANIDE	25	25	0.40 - 170.00	34.31	3.52	20.44 - 57.60

WATER FACTORY 21
SUMMARY DATA FOR GENERAL PARAMETERS FILE 1
FOR PERIOD FROM 1JAN80 TO 1APR81
(CONCENTRATIONS FOR CYANIDE AND PHENOL IN UG/L, ALL OTHERS IN MG/L)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
006	METH. BLUE ACTIVE SUBS	24	23	< 0.10 - 0.47	0.21	1.59	0.17 - 0.26
006	PHENOL	27	27	3.30 - 22.00	9.43	1.55	7.94 - 11.20
006	AMMONIA NITROGEN	48	48	13.00 - 67.00	25.27	1.28	23.57 - 27.09
006	ORGANIC NITROGEN	45	35	< 0.10 - 6.00	1.16	1.92	0.94 - 1.44
006	TOT KJELDAHL NITROGEN	45	45	14.00 - 70.00	26.59	1.29	24.67 - 28.65
006	NITRATE NITROGEN	25	25	0.20 - 3.60	0.66	1.85	0.52 - 0.86
006	FREE CHLORINE RESIDUAL	115	28	< 0.10 - 1.00	0.03	4.49	0.02 - 0.05
006	TOTAL CHLORINE RESID.	239	239	0.20 - 18.00	3.53	1.90	3.25 - 3.83
008	TOTAL DISS.SOLIDS	21	21	852.00 -1260.00	990.24	1.12	940.56 -1042.54
008	TOTAL HARDNESS	19	19	170.00 - 300.00	221.42	1.21	202.09 - 242.61
008	MAGNESIUM	22	21	< 0.10 - 7.40	2.46	2.24	1.70 - 3.55
008	SODIUM	22	22	200.00 - 260.00	229.49	1.07	222.63 - 236.56
008	POTASSIUM	1	1	?	?	?	?
008	BORON	22	22	0.30 - 0.80	0.58	1.33	0.51 - 0.66
008	PHOSPHATE	1	1	?	?	?	?
008	CYANIDE	17	16	< 0.10 - 52.00	20.57	2.03	14.15 - 29.09
008	METH. BLUE ACTIVE SUBS	43	4	< 0.10 - 0.12	0.06	1.33	0.04 - 0.10
008	PHENOL	39	15	< 1.00 - 8.70	0.34	5.62	0.13 - 0.88
008	AMMONIA NITROGEN	42	42	15.00 - 64.00	24.48	1.25	22.85 - 26.22
008	ORGANIC NITROGEN	36	22	< 0.10 - 2.70	0.38	2.72	0.24 - 0.58
008	TOT KJELDAHL NITROGEN	36	36	15.00 - 65.00	25.07	1.27	23.17 - 27.13
008	NITRATE NITROGEN	40	40	0.10 - 3.90	0.53	2.50	0.40 - 0.70
008	FREE CHLORINE RESIDUAL	0	0	< 0.10	< 0.10	?	?
008	TOTAL CHLORINE RESID.	0	0	< 0.10	< 0.10	?	?
009	TOTAL DISS.SOLIDS	46	46	622.00 -1270.00	1006.61	1.14	969.71 -1044.91
009	TOTAL HARDNESS	46	46	180.00 - 410.00	231.90	1.20	219.96 - 244.49
009	MAGNESIUM	48	48	0.50 - 8.90	3.05	1.95	2.53 - 3.69
009	SODIUM	48	48	200.00 - 280.00	230.82	1.08	225.98 - 235.77
009	POTASSIUM	48	48	8.40 - 56.00	13.62	1.24	12.81 - 14.47
009	BORON	47	47	0.40 - 1.00	0.61	1.21	0.58 - 0.65
009	PHOSPHATE	1	1	?	?	?	?
009	CYANIDE	39	35	< 0.10 - 260.00	11.56	5.40	6.61 - 20.21
009	METH. BLUE ACTIVE SUBS	43	2	0.10 - 0.10	0.10	?	?
009	PHENOL	0	0	< 1.00	< 1.00	?	?
009	AMMONIA NITROGEN	47	47	1.40 - 41.00	16.03	1.50	14.28 - 18.00
009	ORGANIC NITROGEN	37	27	< 0.10 - 3.10	0.41	3.23	0.26 - 0.65
009	TOT KJELDAHL NITROGEN	37	37	11.00 - 41.00	18.13	1.34	16.50 - 19.92
009	NITRATE NITROGEN	41	41	0.20 - 5.00	1.33	1.85	1.10 - 1.61
009	FREE CHLORINE RESIDUAL	69	44	< 0.10 - 7.70	0.34	5.37	0.21 - 0.56
009	TOTAL CHLORINE RESID.	179	179	1.20 - 67.00	19.46	1.96	17.63 - 21.47
010	TOTAL DISS.SOLIDS	59	59	114.00 - 493.00	232.32	1.41	212.74 - 253.71
010	TOTAL HARDNESS	60	60	8.00 - 110.00	34.26	1.64	30.21 - 38.85
010	MAGNESIUM	61	60	< 0.10 - 2.30	0.53	1.89	0.45 - 0.62
010	SODIUM	60	60	34.00 - 130.00	64.68	1.36	59.84 - 69.90

WATER FACTORY 21
SUMMARY DATA FOR GENERAL PARAMETERS FILE 1
FOR PERIOD FROM 1JAN80 TO 1APR81
(CONCENTRATIONS FOR CYANIDE AND PHENOL IN UG/L. ALL OTHERS IN MG/L)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
010	POTASSIUM	2	2	5.00 - 43.00	14.66	6.24	0.06 -3844.45
010	BORON	61	61	0.20 - 0.80	0.40	1.29	0.38 - 0.43
010	PHOSPHATE	1	0	< 0.10	< 0.10	?	?
010	CYANIDE	50	47	< 0.10 - 80.00	6.32	4.05	4.23 - 9.42
010	METH. BLUE ACTIVE SUBS	58	5	0.10 - 0.10	0.10	?	?
010	PHENOL	27	20	< 1.00 - 4.10	1.37	1.94	1.01 - 1.87
010	AMMONIA NITROGEN	83	83	0.60 - 7.10	2.70	1.75	2.39 - 3.04
010	ORGANIC NITROGEN	50	45	< 0.10 - 2.40	0.28	2.00	0.23 - 0.35
010	TOT KJELDAHL NITROGEN	59	59	0.60 - 7.40	3.04	1.72	2.64 - 3.49
010	NITRATE NITROGEN	52	52	0.10 - 1.80	0.35	2.00	0.29 - 0.43
010	FREE CHLORINE RESIDUAL	239	37	< 0.10 - 4.80	0.00	13.20	0.00 - 0.01
010	TOTAL CHLORINE RESID.	241	241	0.10 - 19.00	1.80	2.07	1.64 - 1.97
22A	TOTAL DISS.SOLIDS	54	54	808.00 -1190.00	976.47	1.11	950.40 -1003.24
22A	TOTAL HARDNESS	54	54	170.00 - 320.00	222.20	1.18	212.71 - 232.12
22A	MAGNESIUM	4	0	< 0.10	< 0.10	?	?
22A	SODIUM	213	213	150.00 - 280.00	223.34	1.10	220.40 - 226.32
22A	POTASSIUM	0	0	< 0.10	< 0.10	?	?
22A	BORON	2	0	< 0.10	< 0.10	?	?
22A	PHOSPHATE	51	13	< 0.10 - 1.20	0.02	4.92	0.01 - 0.05
22A	CYANIDE	0	0	< 0.10	< 0.10	?	?
22A	METH. BLUE ACTIVE SUBS	0	0	< 0.10	< 0.10	?	?
22A	PHENOL	26	20	< 1.00 - 6.40	1.58	1.98	1.15 - 2.17
22A	AMMONIA NITROGEN	2	2	18.00 - 20.00	18.97	1.09	14.45 - 24.92
22A	ORGANIC NITROGEN	2	1	< 0.10	< 0.10	?	?
22A	TOT KJELDAHL NITROGEN	2	2	18.00 - 20.00	18.97	1.09	14.45 - 24.92
22A	NITRATE NITROGEN	47	46	< 0.10 - 3.90	0.46	2.46	0.36 - 0.60
22A	FREE CHLORINE RESIDUAL	0	0	< 0.10	< 0.10	?	?
22A	TOTAL CHLORINE RESID.	1	1	?	?	?	?
22B	TOTAL DISS.SOLIDS	54	53	< 1.00 - 310.00	82.42	1.74	70.97 - 95.72
22B	TOTAL HARDNESS	54	52	< 1.00 - 52.00	4.66	2.65	3.57 - 6.07
22B	MAGNESIUM	49	12	< 0.10 - 1.40	0.02	7.71	0.01 - 0.07
22B	SODIUM	217	217	10.00 - 130.00	20.86	1.54	19.70 - 22.10
22B	POTASSIUM	52	48	< 0.10 - 23.00	1.09	1.78	0.92 - 1.28
22B	BORON	52	52	0.40 - 0.90	0.52	1.22	0.50 - 0.55
22B	PHOSPHATE	53	1	< 0.10	< 0.10	?	?
22B	CYANIDE	43	38	< 0.10 - 41.00	2.26	3.34	1.54 - 3.31
22B	METH. BLUE ACTIVE SUBS	50	2	0.10 - 0.10	0.10	?	?
22B	PHENOL	46	8	< 1.00 - 2.20	0.32	2.43	0.16 - 0.67
22B	AMMONIA NITROGEN	73	73	1.10 - 7.60	2.35	1.43	2.16 - 2.55
22B	ORGANIC NITROGEN	30	20	< 0.10 - 2.20	0.15	4.03	0.08 - 0.29
22B	TOT KJELDAHL NITROGEN	38	38	1.10 - 8.20	2.72	1.47	2.40 - 3.07
22B	NITRATE NITROGEN	47	42	< 0.10 - 2.30	0.25	2.27	0.19 - 0.32
22B	FREE CHLORINE RESIDUAL	30	1	< 0.10	< 0.10	?	?
22B	TOTAL CHLORINE RESID.	40	38	< 0.10 - 0.80	0.29	1.56	0.25 - 0.33

WATER FACTORY 21
SUMMARY DATA FOR GENERAL PARAMETERS FILE 2
FOR PERIOD FROM 1JAN80 TO 1APR81
(UNITS ARE SHOWN WITH CHEMICAL ANALYSIS NAME-(UNITS))

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	TOT COLI (10E5/100ML)	48	48	0.8 - 31.	7.2	2.3	5.7 - 9.1
001	FEC COLI (10E3/100ML)	48	47	< 0.0 - 560.	103.8	2.6	78.9 - 136.6
001	COLOR (UNITS)	63	63	25.00 - 50.00	34.57	1.16	33.33 - 35.86
001	FLUORIDE (MG/L)	27	27	0.52 - 2.00	1.41	1.25	1.29 - 1.54
001	DIS. SULFIDE (MG/L)	46	9	< 1.00 - 4.10	0.46	2.31	0.24 - 0.85
001	SILICATE (MG/L)	56	56	20.00 - 29.00	24.15	1.12	23.47 - 24.85
001	PH (SCALE 1-14)	201	201	7.19 - 7.93	7.48	1.02	7.46 - 7.51
001	ELE. CONDUCTIVITY	203	203	1192.0 - 2867.	1848.4	1.2	1809.9 -1887.7
001	CHLORIDE (MG/L)	182	182	184.30 - 369.40	256.50	1.12	252.45 -260.77
001	CALCIUM (MG/L)	202	202	60.90 - 146.00	85.86	1.16	84.13 - 87.63
001	CARBONATE (MG/L)	3	0	< 0.00	< 0.00	?	?
001	HYDROXIDE (MG/L CACO3)	3	0	< 0.00	< 0.00	?	?
001	BI-CARBONATE (MG/L)	203	203	212.00 - 430.00	275.73	1.10	272.21 -279.30
001	SULFATE (MG/L)	178	178	120.00 - 486.00	300.73	1.26	290.63 -311.19
002	TOT COLI (MPN/100ML)	50	23	< 0.30 - 124.00	0.43	7.30	0.18 - 1.01
002	FEC COLI (MPN/100ML)	50	6	< 0.30 - 10.00	0.03	12.15	0.00 - 0.36
002	COLOR (UNITS)	31	31	10.00 - 27.00	17.60	1.29	16.08 - 19.26
002	FLUORIDE (MG/L)	26	26	0.39 - 1.01	0.88	1.20	0.82 - 0.94
002	DIS. SULFIDE (MG/L)	0	0	< 1.00	< 1.00	?	?
002	SILICATE (MG/L)	57	57	6.80 - 20.00	13.11	1.23	12.42 - 13.83
002	PH (SCALE 1-14)	206	206	1.00 - 11.98	10.81	1.09	10.68 - 10.94
002	ELE. CONDUCTIVITY	206	206	1307.0 - 7630.	1835.7	1.2	1785.0 -1887.9
002	CHLORIDE (MG/L)	185	185	176.50 - 398.40	262.83	1.12	258.63 -267.09
002	CALCIUM (MG/L)	205	205	56.90 - 368.70	87.19	1.30	84.10 - 90.40
002	CARBONATE (MG/L)	206	206	40.00 - 160.00	77.27	1.27	74.77 - 79.86
002	HYDROXIDE (MG/L CACO3)	206	206	46.00 - 530.00	146.33	1.47	138.78 -154.30
002	BI-CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
002	SULFATE (MG/L)	178	178	170.00 - 416.00	260.83	1.18	254.62 -267.18
003	TOT COLI (MPN/100ML)	0	0	< 0.30	< 0.30	?	?
003	FEC COLI (MPN/100ML)	0	0	< 0.30	< 0.30	?	?
003	COLOR (UNITS)	0	0	< 5.00	< 5.00	?	?
003	FLUORIDE (MG/L)	0	0	< 0.10	< 0.10	?	?
003	DIS. SULFIDE (MG/L)	0	0	< 1.00	< 1.00	?	?
003	SILICATE (MG/L)	0	0	< 1.00	< 1.00	?	?
003	PH (SCALE 1-14)	16	16	10.79 - 11.24	11.06	1.01	11.00 - 11.12
003	ELE. CONDUCTIVITY	0	0	< 0.00	< 0.00	?	?
003	CHLORIDE (MG/L)	0	0	< 0.00	< 0.00	?	?
003	CALCIUM (MG/L)	0	0	< 0.00	< 0.00	?	?
003	CARBONATE (MG/L)	15	15	48.00 - 88.00	70.87	1.18	64.55 - 77.80
003	HYDROXIDE (MG/L CACO3)	15	15	68.00 - 134.00	97.33	1.25	85.93 -110.24
003	BI-CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
003	SULFATE (MG/L)	0	0	< 0.00	< 0.00	?	?

WATER FACTORY 21
SUMMARY DATA FOR GENERAL PARAMETERS FILE 2
FOR PERIOD FROM 1JAN80 TO 1APR81
(UNITS ARE SHOWN WITH CHEMICAL ANALYSIS NAME-(UNITS))

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
004	TOT COLI (MPN/100ML)	0	0	< 0.30	< 0.30	?	?
004	FEC COLI (MPN/100ML)	0	0	< 0.30	< 0.30	?	?
004	COLOR (UNITS)	22	22	10.00 - 22.00	16.61	1.30	14.77 - 18.67
004	FLUORIDE (MG/L)	22	22	0.41 - 1.08	0.84	1.25	0.76 - 0.92
004	DIS. SULFIDE (MG/L)	1	0	< 1.00	< 1.00	?	?
004	SILICATE (MG/L)	21	21	6.50 - 19.00	13.00	1.23	11.84 - 14.27
004	PH (SCALE 1-14)	198	198	1.00 - 11.88	10.78	1.07	10.68 - 10.88
004	ELE. CONDUCTIVITY	1	1	?	?	?	?
004	CHLORIDE (MG/L)	179	179	212.70 - 354.50	264.43	1.11	260.45 -268.47
004	CALCIUM (MG/L)	182	182	54.50 - 296.60	82.04	1.30	79.01 - 85.18
004	CARBONATE (MG/L)	198	198	40.00 - 140.00	77.99	1.25	75.58 - 80.47
004	HYDROXIDE (MG/L CACO3)	198	198	40.00 - 710.00	115.67	1.50	109.28 -122.44
004	BI-CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
004	SULFATE (MG/L)	173	173	23.00 - 384.00	256.40	1.26	247.73 -265.38
005	TOT COLI (MPN/100ML)	0	0	< 0.30	< 0.30	?	?
005	FEC COLI (MPN/100ML)	0	0	< 0.30	< 0.30	?	?
005	COLOR (UNITS)	0	0	< 5.00	< 5.00	?	?
005	FLUORIDE (MG/L)	0	0	< 0.10	< 0.10	?	?
005	DIS. SULFIDE (MG/L)	0	0	< 1.00	< 1.00	?	?
005	SILICATE (MG/L)	0	0	< 1.00	< 1.00	?	?
005	PH (SCALE 1-14)	23	23	3.00 - 8.93	7.59	1.16	7.11 - 8.11
005	ELE. CONDUCTIVITY	202	202	1147.0 - 3413.	1810.4	1.2	1775.6 -1845.8
005	CHLORIDE (MG/L)	182	182	212.70 - 343.90	276.27	1.10	272.49 -280.09
005	CALCIUM (MG/L)	203	203	48.10 - 264.30	83.12	1.26	80.51 - 85.81
005	CARBONATE (MG/L)	7	7	44.00 - 70.00	55.26	1.24	45.63 - 66.93
005	HYDROXIDE (MG/L CACO3)	2	2	4.00 - 18.00	8.49	3.60	0.17 -416.17
005	BI-CARBONATE (MG/L)	201	199	< 0.00 - 352.00	131.17	1.74	121.42 -141.70
005	SULFATE (MG/L)	176	176	180.00 - 950.00	286.75	1.32	275.31 -298.66
006	TOT COLI (MPN/100ML)	184	2	< 0.30 - 8.30	0.00	733.13	0.00 - 82.31
006	FEC COLI (MPN/100ML)	185	4	< 0.30 - 20.00	0.00	197.08	0.00 - 0.02
006	COLOR (UNITS)	27	27	8.00 - 25.00	14.90	1.32	13.35 - 16.62
006	FLUORIDE (MG/L)	25	25	0.43 - 1.10	0.85	1.20	0.79 - 0.92
006	DIS. SULFIDE (MG/L)	0	0	< 1.00	< 1.00	?	?
006	SILICATE (MG/L)	25	25	9.20 - 18.00	13.93	1.17	13.06 - 14.87
006	PH (SCALE 1-14)	201	201	3.28 - 9.26	7.57	1.08	7.49 - 7.65
006	ELE. CONDUCTIVITY	183	183	177.0 - 3510.	1828.5	1.2	1786.5 -1871.3
006	CHLORIDE (MG/L)	181	181	212.70 - 361.60	279.09	1.11	275.04 -283.20
006	CALCIUM (MG/L)	201	201	52.10 - 251.50	82.31	1.26	79.75 - 84.95
006	CARBONATE (MG/L)	7	7	40.00 - 76.00	48.56	1.34	37.51 - 62.87
006	HYDROXIDE (MG/L CACO3)	0	0	< 0.00	< 0.00	?	?
006	BI-CARBONATE (MG/L)	203	201	< 0.00 - 286.00	129.86	1.79	119.85 -140.71
006	SULFATE (MG/L)	175	175	170.00 - 875.00	285.36	1.31	274.07 -297.12
008	TOT COLI (MPN/100ML)	134	35	< 0.30 - 20.00	0.19	5.05	0.11 - 0.32
008	FEC COLI (MPN/100ML)	136	1	< 0.30	< 0.30	?	?

WATER FACTORY 21
SUMMARY DATA FOR GENERAL PARAMETERS FILE 2
FOR PERIOD FROM 1JAN80 TO 1APR81
(UNITS ARE SHOWN WITH CHEMICAL ANALYSIS NAME-(UNITS))

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
008	COLOR (UNITS)	22	5	< 5.00 - 9.00	4.69	1.42	3.13 - 7.03
008	FLUORIDE (MG/L)	20	20	0.51 - 1.18	0.86	1.23	0.78 - 0.94
008	DIS. SULFIDE (MG/L)	36	0	< 1.00	< 1.00	?	?
008	SILICATE (MG/L)	20	20	10.00 - 18.00	13.69	1.18	12.67 - 14.78
008	PH (SCALE 1-14)	142	142	5.94 - 8.53	7.20	1.05	7.15 - 7.25
008	ELE. CONDUCTIVITY	1	1	?	?	?	?
008	CHLORIDE (MG/L)	1	1	?	?	?	?
008	CALCIUM (MG/L)	0	0	< 0.00	< 0.00	?	?
008	CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
008	HYDROXIDE (MG/L CACO3)	0	0	< 0.00	< 0.00	?	?
008	BI-CARBONATE (MG/L)	7	7	88.00 - 174.00	133.52	1.28	107.23 -166.25
008	SULFATE (MG/L)	1	0	< 0.00	< 0.00	?	?
009	TOT COLI (MPN/100ML)	136	2	< 0.30 - 1.30	0.17	2.18	0.02 - 1.84
009	FEC COLI (MPN/100ML)	136	0	< 0.30	< 0.30	?	?
009	COLOR (UNITS)	49	2	6.00 - 6.00	6.00	?	?
009	FLUORIDE (MG/L)	46	46	0.38 - 1.12	0.73	1.32	0.68 - 0.79
009	DIS. SULFIDE (MG/L)	39	0	< 1.00	< 1.00	?	?
009	SILICATE (MG/L)	45	45	11.00 - 19.00	13.88	1.14	13.36 - 14.42
009	PH (SCALE 1-14)	143	143	2.67 - 7.72	5.29	1.26	5.10 - 5.50
009	ELE. CONDUCTIVITY	136	136	1549.0 - 4088.	1923.9	1.2	1874.7 -1974.4
009	CHLORIDE (MG/L)	134	134	234.00 - 453.80	334.20	1.13	327.25 -341.29
009	CALCIUM (MG/L)	144	144	4.80 - 265.90	84.85	1.30	81.26 - 88.61
009	CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
009	HYDROXIDE (MG/L CACO3)	0	0	< 0.00	< 0.00	?	?
009	BI-CARBONATE (MG/L)	141	119	< 0.00 - 150.00	44.53	2.11	38.93 - 50.93
009	SULFATE (MG/L)	132	131	< 0.00 - 770.00	272.90	1.35	259.34 -287.16
010	TOT COLI (MPN/100ML)	184	6	< 0.30 - 15.00	0.00	36.67	0.00 - 0.03
010	FEC COLI (MPN/100ML)	184	0	< 0.30	< 0.30	?	?
010	COLOR (UNITS)	63	56	< 5.00 - 45.00	11.08	1.82	9.48 - 12.96
010	FLUORIDE (MG/L)	59	59	0.21 - 0.78	0.40	1.35	0.37 - 0.43
010	DIS. SULFIDE (MG/L)	1	0	< 1.00	< 1.00	?	?
010	SILICATE (MG/L)	0	0	< 1.00	< 1.00	?	?
010	PH (SCALE 1-14)	202	202	5.92 - 8.38	7.17	1.05	7.13 - 7.22
010	ELE. CONDUCTIVITY	204	204	108.0 - 1600.	419.0	1.5	397.8 - 441.3
010	CHLORIDE (MG/L)	181	181	21.30 - 159.50	57.68	1.48	54.47 - 61.06
010	CALCIUM (MG/L)	203	203	1.90 - 59.30	11.04	1.86	10.14 - 12.03
010	CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
010	HYDROXIDE (MG/L CACO3)	0	0	< 0.00	< 0.00	?	?
010	BI-CARBONATE (MG/L)	204	204	3.40 - 154.00	65.01	1.43	61.91 - 68.28
010	SULFATE (MG/L)	177	177	1.20 - 230.00	37.56	2.25	33.33 - 42.32
22A	TOT COLI (MPN/100ML)	166	20	< 0.30 - 10.00	0.10	6.11	0.04 - 0.22
22A	FEC COLI (MPN/100ML)	167	1	< 0.30	< 0.30	?	?
22A	COLOR (UNITS)	1	1	?	?	?	?
22A	FLUORIDE (MG/L)	0	0	< 0.10	< 0.10	?	?

WATER FACTORY 21

SUMMARY DATA FOR GENERAL PARAMETERS FILE 2
FOR PERIOD FROM 1JAN80 TO 1APR81
(UNITS ARE SHOWN WITH CHEMICAL ANALYSIS NAME-(UNITS))

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
22A	DIS. SULFIDE (MG/L)	1	0	< 1.00	< 1.00	?	?
22A	SILICATE (MG/L)	1	1	?	?	?	?
22A	PH (SCALE 1-14)	0	0	< 0.00	< 0.00	?	?
22A	ELE. CONDUCTIVITY	185	185	1325.0 - 4370.	1875.5	1.2	1827.7 -1924.6
22A	CHLORIDE (MG/L)	181	181	212.70 - 375.80	281.46	1.10	277.56 -285.42
22A	CALCIUM (MG/L)	185	185	61.70 - 276.30	82.28	1.19	80.21 - 84.41
22A	CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
22A	HYDROXIDE (MG/L CACO3)	0	0	< 0.00	< 0.00	?	?
22A	BI-CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
22A	SULFATE (MG/L)	163	163	29.00 - 756.00	273.83	1.41	259.82 -288.58
22B	TOT COLI (MPN/100ML)	165	141	< 0.30 - 24.00	2.51	2.91	2.10 - 2.99
22B	FEC COLI (MPN/100ML)	165	0	< 0.30	< 0.30	?	?
22B	COLOR (UNITS)	56	0	< 5.00	< 5.00	?	?
22B	FLUORIDE (MG/L)	54	47	< 0.10 - 0.53	0.16	1.39	0.14 - 0.17
22B	DIS. SULFIDE (MG/L)	38	0	< 1.00	< 1.00	?	?
22B	SILICATE (MG/L)	51	51	2.00 - 6.00	3.36	1.37	3.08 - 3.66
22B	PH (SCALE 1-14)	166	166	6.19 - 7.25	6.86	1.03	6.83 - 6.90
22B	ELE. CONDUCTIVITY	185	185	60.0 - 356.	150.4	1.4	143.4 - 157.7
22B	CHLORIDE (MG/L)	180	180	8.50 - 95.70	29.14	1.41	27.72 - 30.63
22B	CALCIUM (MG/L)	184	2	< 0.00 - 4.00	0.01	8.68	0.00 - 8.48
22B	CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
22B	HYDROXIDE (MG/L CACO3)	0	0	< 0.00	< 0.00	?	?
22B	BI-CARBONATE (MG/L)	168	168	0.90 - 80.00	17.07	1.38	16.26 - 17.93
22B	SULFATE (MG/L)	163	141	< 0.00 - 520.00	1.37	2.80	1.15 - 1.62
22C	TOT COLI (MPN/100ML)	0	0	< 0.30	< 0.30	?	?
22C	FEC COLI (MPN/100ML)	0	0	< 0.30	< 0.30	?	?
22C	COLOR (UNITS)	0	0	< 5.00	< 5.00	?	?
22C	FLUORIDE (MG/L)	0	0	< 0.10	< 0.10	?	?
22C	DIS. SULFIDE (MG/L)	0	0	< 1.00	< 1.00	?	?
22C	SILICATE (MG/L)	0	0	< 1.00	< 1.00	?	?
22C	PH (SCALE 1-14)	0	0	< 0.00	< 0.00	?	?
22C	ELE. CONDUCTIVITY	0	0	< 0.00	< 0.00	?	?
22C	CHLORIDE (MG/L)	0	0	< 0.00	< 0.00	?	?
22C	CALCIUM (MG/L)	183	183	66.10 - 909.80	546.57	1.31	525.80 -568.15
22C	CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
22C	HYDROXIDE (MG/L CACO3)	0	0	< 0.00	< 0.00	?	?
22C	BI-CARBONATE (MG/L)	0	0	< 0.00	< 0.00	?	?
22C	SULFATE (MG/L)	1	0	< 0.00	< 0.00	?	?

WATER FACTORY 21
SUMMARY DATA FOR HEAVY METALS
FOR PERIOD FROM 1JAN80 TO 31MAR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	SILVER	58	58	0.20 - 10.00	1.58	1.95	1.33 - 1.88
001	ARSENIC	58	0	< 5.00	< 5.00	?	?
001	ALUMINUM	56	56	14.00 - 810.00	76.70	2.80	58.58 -100.43
001	BARIUM	58	58	33.00 - 300.00	93.53	1.71	81.44 -107.42
001	BERYLLIUM	58	8	< 1.00 - 3.70	0.30	3.04	0.12 - 0.75
001	CADMIUM	58	58	1.50 - 87.00	9.29	2.36	7.44 - 11.59
001	COBALT	56	41	< 1.00 - 29.00	2.17	3.75	1.45 - 3.25
001	CHROMIUM	57	57	16.00 - 220.00	33.05	1.65	29.02 - 37.64
001	COPPER	58	58	19.00 - 240.00	49.29	1.70	43.03 - 56.47
001	IRON	58	58	41.00 - 400.00	113.85	1.68	99.60 -130.13
001	MERCURY	58	21	< 0.50 - 3.00	0.33	3.03	0.20 - 0.54
001	MANGANESE	58	58	27.00 - 100.00	56.00	1.49	50.53 - 62.07
001	NICKEL	58	58	25.00 - 360.00	76.57	1.70	66.83 - 87.73
001	LEAD	58	58	1.50 - 36.00	4.76	2.06	3.95 - 5.73
001	SELENIUM	58	1	< 5.00	< 5.00	?	?
001	ZINC	58	26	<100.00 - 260.00	85.98	1.51	72.75 -101.62
002	SILVER	27	24	< 0.10 - 4.10	0.38	2.88	0.24 - 0.59
002	ARSENIC	27	0	< 5.00	< 5.00	?	?
002	ALUMINUM	25	23	< 1.00 - 370.00	22.91	5.08	11.35 - 46.21
002	BARIUM	27	27	8.00 - 120.00	35.33	1.89	27.51 - 45.37
002	BERYLLIUM	27	3	< 1.00 - 1.50	0.37	2.01	0.10 - 1.34
002	CADMIUM	27	27	0.30 - 20.00	1.88	3.02	1.22 - 2.91
002	COBALT	25	15	< 1.00 - 77.00	1.15	7.19	0.39 - 3.40
002	CHROMIUM	27	27	2.00 - 130.00	7.98	2.20	5.85 - 10.88
002	COPPER	27	27	2.80 - 39.00	9.41	2.12	6.99 - 12.67
002	IRON	27	27	4.60 - 94.00	18.71	2.21	13.69 - 25.58
002	MERCURY	27	6	< 0.50 - 5.00	0.13	5.73	0.02 - 0.76
002	MANGANESE	27	25	< 0.10 - 41.00	1.33	4.25	0.74 - 2.42
002	NICKEL	27	27	13.00 - 67.00	27.03	1.53	22.87 - 31.94
002	LEAD	27	11	< 1.00 - 20.00	0.53	7.48	0.14 - 2.01
002	SELENIUM	27	0	< 5.00	< 5.00	?	?
002	ZINC	27	1	<100.00	<100.00	?	?
006	SILVER	27	25	< 0.10 - 2.70	0.48	3.18	0.30 - 0.77
006	ARSENIC	27	0	< 5.00	< 5.00	?	?
006	ALUMINUM	25	24	< 1.00 - 260.00	27.24	3.73	15.66 - 47.39
006	BARIUM	27	27	9.60 - 95.00	32.99	1.79	26.21 - 41.51
006	BERYLLIUM	27	2	< 1.00 - 1.70	0.24	2.69	0.01 - 4.76
006	CADMIUM	27	27	0.20 - 10.00	1.71	2.92	1.12 - 2.61
006	COBALT	25	14	< 1.00 - 27.00	1.24	5.67	0.46 - 3.33
006	CHROMIUM	27	27	1.60 - 86.00	6.61	2.00	5.03 - 8.69
006	COPPER	27	27	8.60 - 36.00	18.49	1.50	15.76 - 21.68
006	IRON	27	27	10.00 - 440.00	103.03	2.26	74.66 -142.18
006	MERCURY	27	11	< 0.50 - 1.80	0.41	2.21	0.24 - 0.69
006	MANGANESE	27	27	0.90 - 100.00	5.67	2.37	4.03 - 7.97

WATER FACTORY 21
SUMMARY DATA FOR HEAVY METALS
FOR PERIOD FROM 1JAN80 TO 31MAR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
006	NICKEL	27	27	11.00 - 62.00	24.67	1.63	20.36 - 29.89
006	LEAD	27	9	< 1.00 - 17.00	0.57	7.18	0.13 - 2.53
006	SELENIUM	27	0	< 5.00	< 5.00	?	?
006	ZINC	27	0	<100.00	<100.00	?	?
008	SILVER	23	21	< 0.10 - 3.10	0.34	3.29	0.20 - 0.58
008	ARSENIC	23	1	< 5.00	< 5.00	?	?
008	ALUMINUM	22	22	10.00 - 920.00	44.73	3.08	27.23 - 73.48
008	BARIUM	23	23	9.10 - 100.00	40.30	1.84	30.97 - 52.45
008	BERYLLIUM	23	1	< 1.00	< 1.00	?	?
008	CADMIUM	23	23	0.20 - 6.00	1.35	2.55	0.90 - 2.03
008	COBALT	22	9	< 1.00 - 25.00	0.56	9.48	0.10 - 3.05
008	CHROMIUM	23	23	1.00 - 53.00	3.91	2.55	2.61 - 5.86
008	COPPER	23	22	< 1.00 - 35.00	5.39	2.24	3.77 - 7.70
008	IRON	23	23	11.00 - 98.00	27.49	1.74	21.64 - 34.93
008	MERCURY	23	12	< 0.50 - 3.30	0.39	2.78	0.21 - 0.75
008	MANGANESE	23	23	0.70 - 28.00	3.63	2.51	2.44 - 5.40
008	NICKEL	23	23	8.50 - 50.00	16.30	1.45	13.88 - 19.14
008	LEAD	23	9	< 1.00 - 20.00	0.53	7.06	0.12 - 2.30
008	SELENIUM	23	0	< 5.00	< 5.00	?	?
008	ZINC	23	0	<100.00	<100.00	?	?
009	SILVER	46	41	< 0.10 - 8.20	0.48	3.62	0.32 - 0.71
009	ARSENIC	46	0	< 5.00	< 5.00	?	?
009	ALUMINUM	46	46	1.00 - 600.00	30.92	3.83	20.97 - 45.58
009	BARIUM	46	46	17.00 - 100.00	42.53	1.66	36.73 - 49.25
009	BERYLLIUM	46	3	< 1.00 - 2.70	0.41	2.40	0.08 - 2.04
009	CADMIUM	46	46	0.30 - 5.40	1.24	2.20	0.98 - 1.55
009	COBALT	46	19	< 1.00 - 34.00	0.66	8.44	0.24 - 1.84
009	CHROMIUM	46	46	0.80 - 110.00	6.54	2.77	4.88 - 8.78
009	COPPER	46	46	9.30 - 960.00	153.83	2.88	113.30 -208.86
009	IRON	45	45	17.00 - 530.00	51.29	1.98	42.03 - 62.60
009	MERCURY	46	21	< 0.50 - 3.60	0.57	2.15	0.40 - 0.81
009	MANGANESE	46	46	1.00 - 22.00	4.57	2.08	3.69 - 5.64
009	NICKEL	46	46	3.70 - 62.00	19.27	1.66	16.66 - 22.29
009	LEAD	46	39	< 1.00 - 120.00	4.52	4.04	2.91 - 7.00
009	SELENIUM	46	1	< 5.00	< 5.00	?	?
009	ZINC	46	13	<100.00 - 460.00	53.46	2.33	32.22 - 88.70
010	SILVER	28	21	< 0.10 - 2.70	0.21	3.80	0.11 - 0.38
010	ARSENIC	28	0	< 5.00	< 5.00	?	?
010	ALUMINUM	25	24	< 1.00 - 110.00	16.39	2.58	11.00 - 24.41
010	BARIUM	28	25	< 1.00 - 45.00	6.67	2.64	4.47 - 9.95
010	BERYLLIUM	28	3	5.00 - 5.00	5.00	?	?
010	CADMIUM	50	41	< 0.10 - 2.30	0.20	2.52	0.15 - 0.27
010	COBALT	25	8	< 1.00 - 5.70	0.12	9.42	0.02 - 0.75
010	CHROMIUM	28	16	< 1.00 - 120.00	0.50	11.05	0.14 - 1.78

WATER FACTORY 21
SUMMARY DATA FOR HEAVY METALS
FOR PERIOD FROM 1JAN80 TO 31MAR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
010	COPPER	28	28	1.00 - 23.00	4.98	2.20	3.67 - 6.76
010	IRON	50	49	< 1.00 - 120.00	22.25	1.83	18.78 - 26.37
010	MERCURY	30	7	< 0.50 - 2.30	0.42	2.47	0.19 - 0.93
010	MANGANESE	50	49	< 0.10 - 70.00	2.14	2.70	1.62 - 2.83
010	NICKEL	28	26	< 1.00 - 58.00	4.16	3.03	2.66 - 6.51
010	LEAD	28	5	< 1.00 - 8.00	0.14	7.71	0.01 - 1.50
010	SELENIUM	50	0	< 5.00	< 5.00	?	?
010	ZINC	30	2	<100.00 - 180.00	75.94	1.53	21.03 -274.28
22A	SILVER	15	11	< 0.10 - 2.30	0.41	3.38	0.18 - 0.92
22A	ARSENIC	15	1	< 5.00	< 5.00	?	?
22A	ALUMINUM	14	13	< 1.00 - 650.00	34.71	3.81	15.57 - 77.34
22A	BARIUM	15	15	9.60 - 99.00	35.35	2.04	23.90 - 52.28
22A	BERYLLIUM	15	3	< 1.00 - 5.00	0.07	11.86	0.00 - 6.24
22A	CADMIUM	15	15	0.30 - 17.00	1.60	3.11	0.85 - 2.98
22A	COBALT	14	8	< 1.00 - 28.00	1.01	9.21	0.16 - 6.21
22A	CHROMIUM	15	13	< 1.00 - 10.00	2.35	2.34	1.41 - 3.91
22A	COPPER	15	15	3.60 - 16.00	8.87	1.57	6.93 - 11.37
22A	IRON	15	15	12.00 - 160.00	38.27	2.25	24.49 - 59.80
22A	MERCURY	15	9	< 0.50 - 2.30	0.68	1.83	0.43 - 1.08
22A	MANGANESE	15	15	0.40 - 9.70	1.44	2.45	0.88 - 2.36
22A	NICKEL	15	15	11.00 - 130.00	24.06	1.86	17.10 - 33.85
22A	LEAD	15	3	< 1.00 - 8.40	4.08	1.54	1.84 - 9.07
22A	SELENIUM	15	0	< 5.00	< 5.00	?	?
22A	ZINC	15	0	<100.00	<100.00	?	?
22B	SILVER	51	28	< 0.10 - 1.10	0.15	3.19	0.09 - 0.23
22B	ARSENIC	51	0	< 5.00	< 5.00	?	?
22B	ALUMINUM	50	40	< 1.00 - 140.00	6.12	3.60	4.12 - 9.11
22B	BARIUM	51	33	< 1.00 - 15.00	1.13	3.18	0.76 - 1.68
22B	BERYLLIUM	51	0	< 1.00	< 1.00	?	?
22B	CADMIUM	51	19	< 0.10 - 0.60	0.07	3.16	0.04 - 0.12
22B	COBALT	50	4	< 1.00 - 2.90	0.00	39.85	0.00 - 0.18
22B	CHROMIUM	51	29	< 1.00 - 38.00	0.82	5.24	0.44 - 1.53
22B	COPPER	51	47	< 1.00 - 27.00	3.92	2.16	3.15 - 4.89
22B	IRON	51	37	< 1.00 - 260.00	2.82	5.05	1.67 - 4.75
22B	MERCURY	50	15	< 0.50 - 2.20	0.28	2.79	0.16 - 0.50
22B	MANGANESE	51	27	< 0.10 - 28.00	0.13	13.29	0.05 - 0.36
22B	NICKEL	51	32	< 1.00 - 59.00	1.48	4.28	0.89 - 2.44
22B	LEAD	51	11	< 1.00 - 2.70	0.65	2.06	0.40 - 1.05
22B	SELENIUM	51	0	< 5.00	< 5.00	?	?
22B	ZINC	51	1	<100.00	<100.00	?	?

WATER FACTORY 21
SUMMARY DATA FOR GENERAL PARAMETERS FILE 4
FOR PERIOD FROM 1JAN80 TO 1APR81
(UNITS ARE SHOWN WITH CHEMICAL ANALYSIS NAME-(UNITS))

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	CHEM OXY DEMAND(MG/L)	33	33	37.90 - 69.00	50.36	1.21	47.22 - 53.71
001	TOT ORG CARBON(MG/L)	32	32	9.34 - 68.00	15.72	1.39	14.02 - 17.62
001	TOT ORG HALOGEN(UG/L)	38	38	70.70 - 396.00	131.34	1.45	116.76 -147.75
001	TOT ORG NITROGEN(MG/L)	29	29	0.08 - 6.23	0.70	2.69	0.48 - 1.01
001	UV ABSORBANCE(%ABS)	38	38	0.161 - 0.239	0.188	1.091	0.183 - 0.193
001	THM PRECURSORS(UG/L)	20	20	35.00 - 853.00	296.22	2.62	188.71 -464.98
001	GROSS ALPHA(UCI/L)	25	15	< 0.00 - 3.10	0.872	2.49	0.53 - 1.44
001	GROSS BETA(UCI/L)	25	23	< 0.00 - 50.00	21.414	1.86	16.39 - 27.98
002	CHEM OXY DEMAND(MG/L)	18	18	24.50 - 39.60	31.54	1.15	29.48 - 33.73
002	TOT ORG CARBON(MG/L)	16	16	4.53 - 13.30	9.49	1.28	8.31 - 10.83
002	TOT ORG HALOGEN(UG/L)	19	19	48.80 - 229.00	107.35	1.52	87.78 -131.30
002	TOT ORG NITROGEN(MG/L)	14	14	0.08 - 1.08	0.36	2.58	0.21 - 0.63
002	UV ABSORBANCE(%ABS)	19	19	0.106 - 0.213	0.139	1.154	0.130 - 0.149
002	THM PRECURSORS(UG/L)	11	11	26.00 - 795.00	222.25	3.42	98.40 -501.98
002	GROSS ALPHA(UCI/L)	14	5	< 0.00 - 1.80	0.378	2.67	0.12 - 1.17
002	GROSS BETA(UCI/L)	14	14	1.40 - 46.00	15.53	2.78	8.65 - 27.88
004	CHEM OXY DEMAND(MG/L)	18	18	23.80 - 37.80	30.81	1.14	28.88 - 32.87
004	TOT ORG CARBON(MG/L)	17	17	7.53 - 12.80	9.69	1.20	8.83 - 10.63
004	TOT ORG HALOGEN(UG/L)	20	20	42.00 - 210.00	99.84	1.48	83.23 -119.77
004	TOT ORG NITROGEN(MG/L)	15	15	0.06 - 1.18	0.41	2.49	0.25 - 0.67
004	UV ABSORBANCE(%ABS)	20	20	0.106 - 0.190	0.136	1.149	0.128 - 0.146
004	THM PRECURSORS(UG/L)	11	11	22.00 - 946.00	235.30	3.41	104.19 -531.39
004	GROSS ALPHA(UCI/L)	13	7	< 0.00 - 1.20	0.790	1.39	0.59 - 1.06
004	GROSS BETA(UCI/L)	13	12	< 0.00 - 35.00	12.104	2.20	7.36 - 19.90
006	CHEM OXY DEMAND(MG/L)	18	18	21.40 - 41.70	29.15	1.17	26.98 - 31.49
006	TOT ORG CARBON(MG/L)	15	15	6.90 - 28.90	10.52	1.36	8.88 - 12.46
006	TOT ORG HALOGEN(UG/L)	18	18	54.30 - 485.00	172.91	1.73	131.71 -227.01
006	TOT ORG NITROGEN(MG/L)	13	13	0.06 - 1.75	0.46	2.71	0.25 - 0.83
006	UV ABSORBANCE(%ABS)	18	18	0.130 - 0.237	0.171	1.190	0.157 - 0.186
006	THM PRECURSORS(UG/L)	11	11	11.00 - 700.00	158.93	3.41	70.48 -358.39
006	GROSS ALPHA(UCI/L)	12	5	< 0.00 - 1.80	0.463	2.61	0.15 - 1.40
006	GROSS BETA(UCI/L)	12	10	< 0.00 - 37.00	12.948	2.47	6.85 - 24.47
008	CHEM OXY DEMAND(MG/L)	13	13	4.04 - 43.20	10.45	1.96	6.99 - 15.64
008	TOT ORG CARBON(MG/L)	11	11	0.69 - 33.30	3.62	2.85	1.80 - 7.25
008	TOT ORG HALOGEN(UG/L)	14	13	< 35.00 - 237.00	86.235	1.86	59.46 -125.07
008	TOT ORG NITROGEN(MG/L)	11	11	0.07 - 0.63	0.19	1.88	0.13 - 0.29
008	UV ABSORBANCE(%ABS)	14	12	< 0.000 - 0.530	0.029	4.870	0.011 - 0.078

WATER FACTORY 21
SUMMARY DATA FOR GENERAL PARAMETERS FILE 4
FOR PERIOD FROM 1JAN80 TO 1APR81
(UNITS ARE SHOWN WITH CHEMICAL ANALYSIS NAME-(UNITS))

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
008	THM PRECURSORS(UG/L)	10	10	19.00 - 922.00	175.28	3.65	70.30 -437.04
008	GROSS ALPHA(UCI/L)	10	6	< 0.00 - 1.80	0.562	2.26	0.25 - 1.27
008	GROSS BETA(UCI/L)	10	9	< 0.00 - 27.00	13.382	1.69	9.00 - 19.89
009	CHEM OXY DEMAND(MG/L)	28	28	4.48 - 43.30	10.53	1.66	8.65 - 12.82
009	TOT ORG CARBON(MG/L)	24	24	0.80 - 34.70	3.98	2.06	2.94 - 5.40
009	TOT ORG HALOGEN(UG/L)	32	32	21.10 - 283.00	111.69	1.83	90.53 -137.78
009	TOT ORG NITROGEN(MG/L)	22	22	0.06 - 0.50	0.20	1.89	0.15 - 0.27
009	UV ABSORBANCE(%ABS)	32	32	0.010 - 0.274	0.090	2.109	0.069 - 0.116
009	THM PRECURSORS(UG/L)	22	22	16.00 - 728.00	167.08	3.32	98.35 -283.86
009	GROSS ALPHA(UCI/L)	25	11	< 0.00 - 2.50	0.425	2.62	0.22 - 0.81
009	GROSS BETA(UCI/L)	25	21	< 0.00 - 50.00	13.676	2.51	9.01 - 20.77
22A	CHEM OXY DEMAND(MG/L)	2	2	14.10 - 19.40	16.54	1.31	7.24 - 37.77
22A	TOT ORG CARBON(MG/L)	1	1	?	?	?	?
22A	TOT ORG HALOGEN(UG/L)	9	9	67.60 - 168.00	117.16	1.33	94.70 -144.94
22A	TOT ORG NITROGEN(MG/L)	1	1	?	?	?	?
22A	UV ABSORBANCE(%ABS)	2	2	0.084 - 0.096	0.090	1.120	0.064 - 0.127
22A	THM PRECURSORS(UG/L)	0	0	< 0.00	< 0.00	?	?
22A	GROSS ALPHA(UCI/L)	0	0	< 0.00	< 0.00	?	?
22A	GROSS BETA(UCI/L)	0	0	< 0.00	< 0.00	?	?
22B	CHEM OXY DEMAND(MG/L)	28	27	< 0.50 - 3.69	1.320	2.20	0.97 - 1.80
22B	TOT ORG CARBON(MG/L)	29	29	0.35 - 59.20	1.09	2.58	0.76 - 1.56
22B	TOT ORG HALOGEN(UG/L)	31	31	0.20 - 185.00	23.55	3.97	14.50 - 38.26
22B	TOT ORG NITROGEN(MG/L)	26	26	0.01 - 0.50	0.09	3.02	0.06 - 0.14
22B	UV ABSORBANCE(%ABS)	31	31	0.011 - 0.084	0.023	1.657	0.019 - 0.027
22B	THM PRECURSORS(UG/L)	21	21	1.00 - 800.00	94.35	7.11	38.73 -229.81
22B	GROSS ALPHA(UCI/L)	26	12	< 0.00 - 14.00	0.482	4.09	0.20 - 1.17
22B	GROSS BETA(UCI/L)	26	15	< 0.00 - 39.00	3.598	4.12	1.65 - 7.83

WATER FACTORY 21
SUMMARY DATA FOR TURBIDITY FILE
FOR PERIOD FROM 1JAN80 TO 1APR81
(CONCENTRATIONS ARE IN FTU, DETECTION LIMIT=0.01 FTU)

LOCATION	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
Q1	228	228	2.10 - 26.20	6.22	1.70	5.80 - 6.66
Q2	226	226	0.15 - 2.68	0.70	1.68	0.66 - 0.75
Q4	0	0	< 0.01	< 0.01	?	?
Q6	229	229	0.05 - 3.48	0.12	1.57	0.12 - 0.13
Q8	0	0	< 0.01	< 0.01	?	?
Q9	0	0	< 0.01	< 0.01	?	?
Q10	229	229	0.08 - 0.58	0.27	1.32	0.26 - 0.28
Q22A	0	0	< 0.01	< 0.01	?	?
Q22B	0	0	< 0.01	< 0.01	?	?

WATER FACTORY 21
SUMMARY DATA FOR TOTAL ORGANIC CARBON FILE 1

FOR PERIOD FROM 1JAN80 TO 31MAR81
(CONCENTRATIONS ARE IN MG/L, DETECTION LIMIT=20 UG/L)

LOCATION	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
Q1	143	143	10.40 - 22.50	14.68	1.13	14.39 - 14.97
Q2	143	143	4.80 - 20.50	10.77	1.26	10.37 - 11.18
Q4	13	13	3.10 - 13.20	9.78	1.39	8.03 - 11.90
Q6	143	143	7.00 - 18.00	11.78	1.17	11.49 - 12.09
Q8	121	120	< 0.02 - 9.50	4.68	1.37	4.42 - 4.95
Q9	118	118	2.00 - 10.30	5.78	1.35	5.48 - 6.10
Q10	143	143	0.20 - 6.00	1.47	1.55	1.37 - 1.58
Q22A	129	129	3.40 - 15.00	6.31	1.23	6.09 - 6.53
Q22B	129	127	< 0.02 - 4.00	0.73	1.74	0.66 - 0.80

WATER FACTORY 21
SUMMARY DATA FOR CHEMCIAL OXYGEN DEMAND FILE 1

FOR PERIOD FROM 1JAN80 TO 31MAR81
(CONCENTRATIONS ARE IN MG/L, DETECTION LIMIT=1.0 MG/L)

LOCATION	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
Q1	248	248	27.00 - 113.00	53.39	1.28	51.75 - 55.08
Q2	248	248	21.00 - 46.00	29.94	1.16	29.38 - 30.50
Q4	24	24	24.00 - 39.00	29.67	1.16	27.83 - 31.63
Q6	248	248	16.00 - 43.00	28.86	1.16	28.34 - 29.39
Q8	184	182	< 1.00 - 126.00	8.82	1.74	8.14 - 9.55
Q9	182	181	< 1.00 - 19.00	8.42	1.63	7.85 - 9.05
Q10	248	231	< 1.00 - 11.00	3.56	1.60	3.35 - 3.78
Q22A	222	222	9.00 - 26.00	14.52	1.25	14.11 - 14.95
Q22B	220	48	< 1.00 - 10.00	0.85	2.41	0.67 - 1.10

WATER FACTORY 21
SUMMARY DATA FOR UV FILE

FOR PERIOD FROM 26AUG80 TO 01APR81
(CONCENTRATIONS ARE IN FTU, DETECTION LIMIT=0.01 FTU)

LOCATION	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
Q1	112	112	0.941 - 1.930	1.290	1.181	1.251 - 1.330
Q2	113	113	0.598 - 1.354	0.812	1.135	0.794 - 0.832
Q4	11	11	0.633 - 0.858	0.743	1.113	0.692 - 0.797
Q6	113	113	0.793 - 1.357	1.057	1.108	1.037 - 1.077
Q8	102	101	< 0.001 - 0.512	0.256	1.909	0.226 - 0.291
Q9	102	102	0.345 - 1.626	0.814	1.324	0.771 - 0.860
Q10	112	112	0.201 - 0.763	0.354	1.401	0.333 - 0.377
Q22A	104	104	0.301 - 0.736	0.518	1.194	0.501 - 0.536
Q22B	113	104	< 0.001 - 0.299	0.092	1.586	0.085 - 0.101
Q1_CENT	113	112	< 0.001 - 0.998	0.108	4.199	0.083 - 0.141
Q2_CENT	113	113	0.600 - 1.000	0.721	1.142	0.704 - 0.739

WATER FACTORY 21
SUMMARY DATA FOR VOA CONSTITUENTS
FOR PERIOD FROM 1JAN80 TO 9APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	CHLOROFORM	39	39	1.79 - 8.42	3.67	1.40	3.30 - 4.08
001	1,1,1-TRICHLOROETHANE	38	38	0.93 - 17.23	5.47	2.26	4.22 - 7.08
001	CARBON TETRACHLORIDE	38	21	<0.05 - 0.26	0.07	1.87	0.05 - 0.09
001	BROMODICHLOROMETHANE	39	38	<0.05 - 1.29	0.63	1.52	0.55 - 0.71
001	TRICHLOROETHYLENE	39	39	0.15 - 5.80	1.47	2.39	1.12 - 1.93
001	DIBROMOCHLOROMETHANE	39	39	0.24 - 1.65	0.86	1.51	0.76 - 0.95
001	TETRACHLOROETHYLENE	40	40	0.65 - 36.70	6.45	2.67	4.76 - 8.75
001	BROMOFORM	36	31	<0.20 - 2.99	0.53	2.04	0.41 - 0.68
002	CHLOROFORM	15	15	1.79 - 6.17	3.95	1.35	3.35 - 4.65
002	1,1,1-TRICHLOROETHANE	16	16	0.59 - 13.90	4.21	2.49	2.60 - 6.83
002	CARBON TETRACHLORIDE	15	10	<0.05 - 0.18	0.07	1.65	0.05 - 0.10
002	BROMODICHLOROMETHANE	16	16	0.37 - 1.38	0.72	1.53	0.57 - 0.90
002	TRICHLOROETHYLENE	16	16	0.11 - 3.29	1.07	2.65	0.64 - 1.80
002	DIBROMOCHLOROMETHANE	16	16	0.30 - 1.42	0.79	1.55	0.63 - 0.99
002	TETRACHLOROETHYLENE	16	16	0.64 - 21.30	4.65	2.90	2.64 - 8.17
002	BROMOFORM	12	11	<0.20 - 2.57	0.60	2.21	0.35 - 1.01
004	CHLOROFORM	17	17	0.22 - 1.49	0.60	1.80	0.45 - 0.81
004	1,1,1-TRICHLOROETHANE	17	12	<0.05 - 0.51	0.12	2.24	0.07 - 0.21
004	CARBON TETRACHLORIDE	16	8	<0.05 - 0.08	0.06	1.22	0.05 - 0.07
004	BROMODICHLOROMETHANE	17	11	<0.05 - 0.26	0.07	2.13	0.04 - 0.12
004	TRICHLOROETHYLENE	17	7	<0.05 - 0.21	0.06	2.20	0.03 - 0.12
004	DIBROMOCHLOROMETHANE	17	15	<0.10 - 0.36	0.15	1.56	0.12 - 0.20
004	TETRACHLOROETHYLENE	17	13	<0.05 - 0.54	0.16	1.82	0.11 - 0.23
004	BROMOFORM	15	6	<0.20 - 0.78	0.15	2.59	0.06 - 0.39
006	CHLOROFORM	19	19	2.27 - 9.43	5.00	1.50	4.11 - 6.08
006	1,1,1-TRICHLOROETHANE	18	15	<0.05 - 0.72	0.12	2.43	0.07 - 0.19
006	CARBON TETRACHLORIDE	19	15	<0.05 - 0.40	0.11	2.29	0.07 - 0.17
006	BROMODICHLOROMETHANE	19	19	0.31 - 10.14	2.41	2.26	1.63 - 3.57
006	TRICHLOROETHYLENE	18	3	<0.05 - 3.87	0.00	*****	0.00 - 3.12
006	DIBROMOCHLOROMETHANE	19	18	<0.10 - 8.52	1.71	2.74	1.04 - 2.81
006	TETRACHLOROETHYLENE	19	17	<0.05 - 3.87	0.11	2.92	0.06 - 0.19
006	BROMOFORM	18	17	<0.20 - 3.71	1.05	2.18	0.70 - 1.56
008	CHLOROFORM	15	15	0.19 - 8.58	1.97	3.92	0.93 - 4.16
008	1,1,1-TRICHLOROETHANE	15	10	<0.05 - 0.49	0.11	2.56	0.06 - 0.21
008	CARBON TETRACHLORIDE	15	11	<0.05 - 0.25	0.07	2.14	0.04 - 0.11
008	BROMODICHLOROMETHANE	15	8	<0.05 - 2.92	0.50	3.52	0.18 - 1.41
008	TRICHLOROETHYLENE	15	5	<0.05 - 2.15	0.02	9.74	0.00 - 0.29
008	DIBROMOCHLOROMETHANE	14	7	<0.10 - 1.35	0.23	3.42	0.08 - 0.70
008	TETRACHLOROETHYLENE	14	6	<0.05 - 4.88	0.02	36.43	0.00 - 0.75
008	BROMOFORM	15	3	<0.20 - 1.63	0.02	10.68	0.00 - 1.77
009	CHLOROFORM	27	27	1.21 - 17.40	6.45	2.21	4.72 - 8.82

WATER FACTORY 21
SUMMARY DATA FOR VOA CONSTITUENTS
FOR PERIOD FROM 1JAN80 TO 9APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
009	1,1,1-TRICHLOROETHANE	27	21	<0.05 - 0.36	0.10	1.94	0.07 - 0.13
009	CARBON TETRACHLORIDE	25	24	<0.05 - 2.04	0.35	2.60	0.23 - 0.52
009	BROMODICHLOROMETHANE	27	27	0.14 - 11.90	2.38	3.01	1.54 - 3.67
009	TRICHLOROETHYLENE	24	8	<0.05 - 1.81	0.04	7.95	0.01 - 0.22
009	DIBROMOCHLOROMETHANE	27	27	0.26 - 9.08	1.75	2.74	1.18 - 2.60
009	TETRACHLOROETHYLENE	27	26	<0.05 - 4.96	1.05	2.06	0.79 - 1.41
009	BROMOFORM	24	21	<0.20 - 4.53	0.87	2.94	0.53 - 1.41
22A	CHLOROFORM	6	6	3.40 - 7.77	5.66	1.37	4.14 - 7.73
22A	1,1,1-TRICHLOROETHANE	6	6	0.08 - 0.27	0.16	1.65	0.09 - 0.26
22A	CARBON TETRACHLORIDE	6	4	<0.05 - 0.15	0.07	1.88	0.03 - 0.17
22A	BROMODICHLOROMETHANE	6	6	1.40 - 5.03	2.76	1.70	1.62 - 4.67
22A	TRICHLOROETHYLENE	5	0	<0.05	<0.05	?	?
22A	DIBROMOCHLOROMETHANE	6	6	1.05 - 3.65	1.85	1.75	1.05 - 3.24
22A	TETRACHLOROETHYLENE	6	3	<0.05 - 0.17	0.04	2.70	0.01 - 0.27
22A	BROMOFORM	6	6	0.37 - 1.65	0.83	1.77	0.47 - 1.47
22B	CHLOROFORM	33	33	0.38 - 2.06	1.21	1.40	1.07 - 1.35
22B	1,1,1-TRICHLOROETHANE	33	18	<0.05 - 0.66	0.06	2.37	0.04 - 0.09
22B	CARBON TETRACHLORIDE	32	19	<0.05 - 0.11	0.06	1.32	0.05 - 0.07
22B	BROMODICHLOROMETHANE	33	31	<0.05 - 2.56	0.51	2.12	0.39 - 0.67
22B	TRICHLOROETHYLENE	33	4	<0.05 - 0.40	0.01	8.19	0.00 - 0.12
22B	DIBROMOCHLOROMETHANE	32	32	0.26 - 3.35	0.70	1.97	0.55 - 0.89
22B	TETRACHLOROETHYLENE	33	16	<0.05 - 0.15	0.06	1.78	0.04 - 0.08
22B	BROMOFORM	33	23	<0.20 - 1.19	0.31	2.04	0.23 - 0.43

WATER FACTORY 21
SUMMARY DATA FOR CLSA CONSTITUENTS
FOR PERIOD FROM 1JAN80 TO 9APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	ETHYL BENZENE	30	24	<0.01 - 0.58	0.06	4.68	0.03 - 0.12
001	P-XYLENE	31	25	<0.01 - 0.75	0.05	4.05	0.03 - 0.09
001	M-XYLENE	32	27	<0.01 - 2.93	0.15	3.83	0.09 - 0.25
001	CHLOROBENZENE	37	30	<0.01 - 3.06	0.11	4.69	0.06 - 0.20
001	HEPTALDEHYDE	37	24	<0.01 - 0.93	0.07	4.05	0.04 - 0.13
001	STYRENE	35	26	<0.01 - 1.09	0.03	6.15	0.01 - 0.06
001	1,3-DICHLOROBENZENE	37	37	0.08 - 1.49	0.39	2.16	0.31 - 0.51
001	1,4-DICHLOROBENZENE	37	37	0.56 - 5.67	2.21	1.68	1.87 - 2.61
001	1,2-DICHLOROBENZENE	37	37	0.12 - 6.66	1.08	2.37	0.82 - 1.43
001	1,2,4-TRICHLOROBENZENE	37	36	<0.01 - 2.08	0.53	2.06	0.42 - 0.67
001	NAPTHALENE	37	33	<0.01 - 2.46	0.20	3.29	0.13 - 0.29
001	2-METHYL NAPTHALENE	31	22	<0.01 - 0.24	0.04	3.53	0.02 - 0.07
001	1-METHYL NAPTHALENE	32	21	<0.01 - 0.32	0.04	3.45	0.02 - 0.07
001	HEPTYLCYANIDE	36	4	<0.01 - 1.55	0.00	24.98	0.00 - 0.17
002	ETHYL BENZENE	16	16	0.01 - 0.38	0.09	2.67	0.05 - 0.15
002	P-XYLENE	16	15	<0.01 - 0.27	0.06	2.65	0.03 - 0.10
002	M-XYLENE	16	16	0.05 - 1.21	0.20	2.56	0.12 - 0.33
002	CHLOROBENZENE	18	18	0.03 - 1.23	0.19	3.18	0.11 - 0.34
002	HEPTALDEHYDE	18	10	<0.01 - 0.19	0.03	2.80	0.01 - 0.06
002	STYRENE	18	13	<0.01 - 0.17	0.04	3.56	0.02 - 0.08
002	1,3-DICHLOROBENZENE	18	18	0.09 - 0.74	0.24	1.83	0.18 - 0.33
002	1,4-DICHLOROBENZENE	18	18	0.41 - 4.50	1.53	1.86	1.13 - 2.08
002	1,2-DICHLOROBENZENE	18	18	0.14 - 4.18	0.83	2.42	0.54 - 1.29
002	1,2,4-TRICHLOROBENZENE	18	18	0.07 - 1.04	0.34	2.07	0.24 - 0.49
002	NAPTHALENE	18	16	<0.01 - 2.45	0.15	4.72	0.06 - 0.33
002	2-METHYL NAPTHALENE	10	11	<0.01 - 0.21	0.02	4.34	0.01 - 0.04
002	1-METHYL NAPTHALENE	18	11	<0.01 - 0.23	0.02	4.04	0.01 - 0.06
002	HEPTYLCYANIDE	18	2	<0.01 - 0.33	0.02	4.55	0.00 - 2.08
004	ETHYL BENZENE	16	16	0.02 - 0.21	0.06	1.98	0.04 - 0.08
004	P-XYLENE	17	17	0.02 - 0.13	0.03	1.88	0.02 - 0.05
004	M-XYLENE	17	17	0.01 - 0.28	0.09	2.13	0.06 - 0.14
004	CHLOROBENZENE	19	18	<0.01 - 1.22	0.13	2.94	0.08 - 0.22
004	HEPTALDEHYDE	19	11	<0.01 - 0.20	0.03	3.31	0.02 - 0.07
004	STYRENE	19	17	<0.01 - 0.31	0.04	3.25	0.02 - 0.07
004	1,3-DICHLOROBENZENE	18	12	<0.01 - 0.20	0.04	2.49	0.02 - 0.07
004	1,4-DICHLOROBENZENE	19	19	0.05 - 0.70	0.26	1.84	0.20 - 0.35
004	1,2-DICHLOROBENZENE	19	16	<0.01 - 1.06	0.17	3.40	0.09 - 0.33
004	1,2,4-TRICHLOROBENZENE	19	19	0.04 - 0.66	0.17	2.18	0.12 - 0.25
004	NAPTHALENE	19	17	<0.01 - 1.19	0.23	2.52	0.15 - 0.37
004	2-METHYL NAPTHALENE	17	14	<0.01 - 0.50	0.04	4.32	0.02 - 0.09
004	1-METHYL NAPTHALENE	16	13	<0.01 - 0.56	0.05	3.72	0.02 - 0.10
004	HEPTYLCYANIDE	19	2	<0.01 - 1.65	0.00	96.95	0.00 -*****
006	ETHYL BENZENE	16	16	0.01 - 0.34	0.04	2.07	0.03 - 0.06

WATER FACTORY 21
SUMMARY DATA FOR CLSA CONSTITUENTS
FOR PERIOD FROM 1JAN80 TO 9APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
006	P-XYLENE	16	16	0.01 - 0.23	0.04	2.32	0.03 - 0.07
006	M-XYLENE	17	17	0.02 - 0.44	0.08	2.13	0.05 - 0.12
006	CHLOROBENZENE	17	17	0.03 - 2.24	0.16	2.78	0.09 - 0.27
006	HEPTALDEHYDE	17	13	<0.01 - 0.34	0.07	3.22	0.03 - 0.13
006	STYRENE	16	15	<0.01 - 0.67	0.05	3.10	0.03 - 0.09
006	1,3-DICHLOROBENZENE	16	12	<0.01 - 0.18	0.04	2.91	0.02 - 0.08
006	1,4-DICHLOROBENZENE	17	17	0.05 - 0.43	0.19	1.77	0.14 - 0.26
006	1,2-DICHLOROBENZENE	16	16	0.09 - 1.16	0.25	2.20	0.16 - 0.38
006	1,2,4-TRICHLOROBENZENE	17	14	<0.01 - 0.53	0.07	3.39	0.03 - 0.14
006	NAPTHALENE	17	17	0.04 - 1.36	0.23	3.45	0.12 - 0.43
006	2-METHYL NAPTHALENE	17	15	<0.01 - 0.22	0.04	2.89	0.02 - 0.07
006	1-METHYL NAPTHALENE	17	14	<0.01 - 0.14	0.04	2.45	0.02 - 0.06
006	HEPTYLCYANIDE	17	2	<0.01 - 0.06	0.01	2.31	0.00 - 0.17
008	ETHYL BENZENE	13	12	<0.01 - 0.11	0.03	2.68	0.02 - 0.06
008	P-XYLENE	13	11	<0.01 - 0.54	0.02	5.46	0.01 - 0.05
008	M-XYLENE	13	12	<0.01 - 0.97	0.05	3.96	0.02 - 0.12
008	CHLOROBENZENE	13	12	<0.01 - 0.97	0.05	3.36	0.02 - 0.11
008	HEPTALDEHYDE	13	5	<0.01 - 0.04	0.02	1.86	0.01 - 0.03
008	STYRENE	13	11	<0.01 - 0.16	0.01	3.47	0.01 - 0.03
008	1,3-DICHLOROBENZENE	13	4	<0.01 - 0.07	0.01	3.09	0.00 - 0.05
008	1,4-DICHLOROBENZENE	13	8	<0.01 - 0.06	0.02	1.96	0.01 - 0.03
008	1,2-DICHLOROBENZENE	13	11	<0.01 - 0.13	0.03	2.12	0.02 - 0.06
008	1,2,4-TRICHLOROBENZENE	13	8	<0.01 - 0.08	0.01	3.20	0.00 - 0.03
008	NAPTHALENE	13	13	0.03 - 0.30	0.09	2.10	0.06 - 0.14
008	2-METHYL NAPTHALENE	12	5	<0.01 - 0.04	0.01	2.63	0.00 - 0.03
008	1-METHYL NAPTHALENE	12	5	<0.01 - 0.04	0.01	2.72	0.00 - 0.03
008	HEPTYLCYANIDE	13	1	<0.01	<0.01	?	?
009	ETHYL BENZENE	23	18	<0.01 - 1.60	0.04	5.01	0.02 - 0.09
009	P-XYLENE	23	17	<0.01 - 1.49	0.02	5.69	0.01 - 0.06
009	M-XYLENE	24	20	<0.01 - 3.85	0.06	5.54	0.03 - 0.14
009	CHLOROBENZENE	26	22	<0.01 - 2.85	0.10	3.75	0.06 - 0.18
009	HEPTALDEHYDE	26	10	<0.01 - 0.34	0.02	4.87	0.01 - 0.05
009	STYRENE	26	11	<0.01 - 1.66	0.01	11.62	0.00 - 0.04
009	1,3-DICHLOROBENZENE	27	17	<0.01 - 2.58	0.09	9.63	0.03 - 0.29
009	1,4-DICHLOROBENZENE	27	24	<0.01 - 0.40	0.09	2.81	0.06 - 0.13
009	1,2-DICHLOROBENZENE	27	23	<0.01 - 0.82	0.15	2.83	0.09 - 0.23
009	1,2,4-TRICHLOROBENZENE	27	12	<0.01 - 2.48	0.02	9.27	0.00 - 0.07
009	NAPTHALENE	27	25	<0.01 - 1.15	0.10	3.04	0.06 - 0.15
009	2-METHYL NAPTHALENE	27	14	<0.01 - 0.20	0.01	5.64	0.00 - 0.02
009	1-METHYL NAPTHALENE	27	12	<0.01 - 0.11	0.01	4.84	0.00 - 0.02
009	HEPTYLCYANIDE	27	2	<0.01 - 0.72	0.00	*****	0.00 -*****
22A	ETHYL BENZENE	2	2	0.01 - 0.08	0.03	5.87	0.00 - 6.15
22A	P-XYLENE	2	2	0.01 - 0.07	0.03	5.24	0.00 - 4.07
22A	M-XYLENE	2	2	0.02 - 0.15	0.05	5.56	0.00 -10.08

WATER FACTORY 21
SUMMARY DATA FOR CLSA CONSTITUENTS
FOR PERIOD FROM 1JAN80 TO 9APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
22A	CHLOROBENZENE	2	2	0.03 - 0.11	0.06	3.02	0.00 - 1.66
22A	HEPTALDEHYDE	2	2	0.02 - 0.06	0.03	2.55	0.00 - 0.59
22A	STYRENE	2	2	0.02 - 0.20	0.06	7.10	0.00 -24.50
22A	1,3-DICHLOROBENZENE	2	1	<0.01	<0.01	?	?
22A	1,4-DICHLOROBENZENE	2	2	0.03 - 0.06	0.04	1.00	0.01 - 0.26
22A	1,2-DICHLOROBENZENE	2	2	0.04 - 0.06	0.05	1.41	0.02 - 0.14
22A	1,2,4-TRICHLOROBENZENE	1	1	?	?	?	?
22A	NAPTHALENE	2	2	0.07 - 0.09	0.08	1.24	0.04 - 0.15
22A	2-METHYL NAPTHALENE	2	2	0.02 - 0.03	0.02	1.41	0.01 - 0.07
22A	1-METHYL NAPTHALENE	2	2	0.02 - 0.03	0.02	1.41	0.01 - 0.07
22A	HEPTYLCYANIDE	2	0	<0.01	<0.01	?	?
22B	ETHYL BENZENE	34	34	0.02 - 0.35	0.05	2.35	0.04 - 0.07
22B	P-XYLENE	34	34	0.01 - 0.31	0.05	2.41	0.04 - 0.06
22B	M-XYLENE	35	35	0.04 - 0.83	0.12	2.30	0.09 - 0.16
22B	CHLOROBENZENE	35	33	<0.01 - 0.67	0.09	2.60	0.07 - 0.13
22B	HEPTALDEHYDE	36	11	<0.01 - 0.09	0.01	3.11	0.00 - 0.02
22B	STYRENE	36	31	<0.01 - 0.22	0.03	3.15	0.02 - 0.04
22B	1,3-DICHLOROBENZENE	36	23	<0.01 - 0.16	0.02	2.54	0.01 - 0.03
22B	1,4-DICHLOROBENZENE	36	29	<0.01 - 0.30	0.03	2.45	0.02 - 0.04
22B	1,2-DICHLOROBENZENE	36	31	<0.01 - 0.29	0.05	2.08	0.04 - 0.06
22B	1,2,4-TRICHLOROBENZENE	36	18	<0.01 - 0.24	0.01	3.62	0.01 - 0.03
22B	NAPTHALENE	36	35	<0.01 - 0.43	0.09	2.20	0.07 - 0.11
22B	2-METHYL NAPTHALENE	35	21	<0.01 - 0.13	0.01	3.19	0.01 - 0.02
22B	1-METHYL NAPTHALENE	35	18	<0.01 - 0.16	0.01	4.06	0.00 - 0.01
22B	HEPTYLCYANIDE	36	3	<0.01 - 0.72	0.00	*****	0.00 - 0.14

WATER FACTORY 21
SUMMARY DATA FOR CLSA CONSTITUENTS FILE 2
FOR PERIOD FROM 1FEB81 TO 9APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	TOLUENE	7	5	<0.01 - 2.74	0.21	6.56	0.02 - 1.86
001	1,2,4 TRICHLOROBENZENE	7	2	<0.01 - 0.08	0.06	1.25	0.03 - 0.12
001	1,2,3 TRICHLOROBENZENE	7	4	<0.01 - 1.10	0.25	2.59	0.07 - 0.92
001	1,3,5 TRICHLOROBENZENE	7	2	<0.01 - 0.45	0.20	1.85	0.03 - 1.26
002	TOLUENE	4	4	0.15 - 1.09	0.53	2.60	0.14 - 1.99
002	1,2,4 TRICHLOROBENZENE	4	3	<0.01 - 0.16	0.03	4.69	0.00 - 0.54
002	1,2,3 TRICHLOROBENZENE	4	3	<0.01 - 0.58	0.30	2.15	0.07 - 1.22
002	1,3,5 TRICHLOROBENZENE	4	1	<0.01	<0.01	?	?
004	TOLUENE	5	5	0.05 - 1.31	0.28	3.61	0.06 - 1.22
004	1,2,4 TRICHLOROBENZENE	5	3	<0.01 - 0.30	0.09	2.59	0.02 - 0.53
004	1,2,3 TRICHLOROBENZENE	5	4	<0.01 - 0.61	0.16	2.76	0.04 - 0.65
004	1,3,5 TRICHLOROBENZENE	5	2	<0.01 - 0.33	0.04	6.69	0.00 -11.37
006	TOLUENE	2	0	<0.01	<0.01	?	?
006	1,2,4 TRICHLOROBENZENE	2	2	0.03 - 0.12	0.06	3.25	0.00 - 2.17
006	1,2,3 TRICHLOROBENZENE	2	1	<0.01	<0.01	?	?
006	1,3,5 TRICHLOROBENZENE	2	0	<0.01	<0.01	?	?
008	TOLUENE	4	3	<0.01 - 0.24	0.03	9.76	0.00 - 2.24
008	1,2,4 TRICHLOROBENZENE	4	2	<0.01 - 0.04	0.03	1.47	0.01 - 0.09
008	1,2,3 TRICHLOROBENZENE	4	0	<0.01	<0.01	?	?
008	1,3,5 TRICHLOROBENZENE	4	0	<0.01	<0.01	?	?
009	TOLUENE	7	6	<0.01 - 0.81	0.39	1.83	0.21 - 0.72
009	1,2,4 TRICHLOROBENZENE	7	2	<0.01 - 0.08	0.00	9.76	0.00 - 3.64
009	1,2,3 TRICHLOROBENZENE	7	0	<0.01	<0.01	?	?
009	1,3,5 TRICHLOROBENZENE	7	7	0.05 - 0.16	0.10	1.56	0.07 - 0.15
22B	TOLUENE	10	8	<0.01 - 0.27	0.13	1.88	0.08 - 0.22
22B	1,2,4 TRICHLOROBENZENE	10	9	<0.01 - 0.14	0.06	1.65	0.04 - 0.09
22B	1,2,3 TRICHLOROBENZENE	10	0	<0.01	<0.01	?	?
22B	1,3,5 TRICHLOROBENZENE	10	4	<0.01 - 0.12	0.01	7.55	0.00 - 0.10

WATER FACTORY 21
SUMMARY DATA FOR SEA CONSTITUENTS
FOR PERIOD FROM 1JAN80 TO 1APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	AROCLOR 1 2 4 2	24	1	<0.05	<0.05	?	?
001	DIMETHYLPHTHALATE	24	4	<0.30 - *****	0.73	25.51	0.01 -65.78
001	DIETHYLPHTHALATE	24	22	<0.30 - 78.60	21.60	2.28	15.00 -31.11
001	DI-ISOBUTYLPHTHALATE	24	22	<0.30 - 11.70	4.29	2.07	3.11 - 5.91
001	DI-N-BUTYLPHTHALATE	24	3	<0.50 - 12.16	0.01	50.85	0.00 - 7.25
001	DIETHYLHEXYLPHTHALATE	24	8	<4.00 - 32.68	2.32	4.68	0.66 - 8.19
001	LINDANE	24	21	<0.05 - 0.20	0.09	1.52	0.07 - 0.10
001	DDT	24	2	<0.05 - 0.26	0.03	2.94	0.00 - 0.84
001	2,4,6 TCA	23	1	<0.30	<0.30	?	?
001	2,3,4,5 TECA	23	0	<0.30	<0.30	?	?
001	2,3,5,6 TECA	23	0	<0.30	<0.30	?	?
001	PCA	23	15	<0.30 - 2.41	0.75	2.15	0.50 - 1.15
002	AROCLOR 1 2 4 2	14	1	<0.05	<0.05	?	?
002	DIMETHYLPHTHALATE	14	1	<0.30	<0.30	?	?
002	DIETHYLPHTHALATE	14	13	<0.30 - 58.64	27.01	1.61	20.27 -35.99
002	DI-ISOBUTYLPHTHALATE	14	13	<0.30 - 6.37	2.42	2.27	1.48 - 3.96
002	DI-N-BUTYLPHTHALATE	13	0	<0.50	<0.50	?	?
002	DIETHYLHEXYLPHTHALATE	14	0	<4.00	<4.00	?	?
002	LINDANE	14	1	<0.05	<0.05	?	?
002	DDT	14	0	<0.05	<0.05	?	?
002	2,4,6 TCA	14	1	<0.30	<0.30	?	?
002	2,3,4,5 TECA	14	0	<0.30	<0.30	?	?
002	2,3,5,6 TECA	14	0	<0.30	<0.30	?	?
002	PCA	14	9	<0.30 - 1.48	0.35	2.31	0.19 - 0.65
004	AROCLOR 1 2 4 2	15	0	<0.05	<0.05	?	?
004	DIMETHYLPHTHALATE	15	2	<0.30 - 40.23	0.01	*****	0.00 -*****
004	DIETHYLPHTHALATE	15	13	<0.30 - 52.73	13.77	2.91	7.27 -26.09
004	DI-ISOBUTYLPHTHALATE	15	13	<0.30 - 16.39	2.22	3.02	1.15 - 4.30
004	DI-N-BUTYLPHTHALATE	14	0	<0.50	<0.50	?	?
004	DIETHYLHEXYLPHTHALATE	15	3	<4.00 - 11.31	2.27	2.54	0.41 -12.60
004	LINDANE	14	1	<0.05	<0.05	?	?
004	DDT	15	0	<0.05	<0.05	?	?
004	2,4,6 TCA	15	0	<0.30	<0.30	?	?
004	2,3,4,5 TECA	15	0	<0.30	<0.30	?	?
004	2,3,5,6 TECA	15	0	<0.30	<0.30	?	?
004	PCA	15	7	<0.30 - 0.83	0.32	1.94	0.18 - 0.58
006	AROCLOR 1 2 4 2	9	0	<0.05	<0.05	?	?
006	DIMETHYLPHTHALATE	9	2	<0.30 - *****	0.27	91.16	0.00 -*****
006	DIETHYLPHTHALATE	9	8	<0.30 - 37.53	15.03	2.24	7.78 -29.07
006	DI-ISOBUTYLPHTHALATE	9	6	<0.30 - 3.42	1.17	2.49	0.47 - 2.91
006	DI-N-BUTYLPHTHALATE	9	2	<0.50 - 10.47	0.01	*****	0.00 -*****
006	DIETHYLHEXYLPHTHALATE	9	1	<4.00	<4.00	?	?
006	LINDANE	9	3	<0.05 - 0.16	0.02	3.65	0.00 - 0.25

WATER FACTORY 21
SUMMARY DATA FOR SEA CONSTITUENTS
FOR PERIOD FROM 1JAN80 TO 1APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
006	DDT	9	0	<0.05	<0.05	?	?
006	2,4,6 TCA	9	0	<0.30	<0.30	?	?
006	2,3,4,5 TECA	9	0	<0.30	<0.30	?	?
006	2,3,5,6 TECA	9	0	<0.30	<0.30	?	?
006	PCA	9	3	<0.30 - 0.78	0.17	2.75	0.03 - 1.07
008	AROCLOR 1 2 4 2	5	0	<0.05	<0.05	?	?
008	DIMETHYLPHTHALATE	5	1	<0.30	<0.30	?	?
008	DIETHYLPHTHALATE	5	0	<0.30	<0.30	?	?
008	DI-ISOBUTYLPHTHALATE	5	0	<0.30	<0.30	?	?
008	DI-N-BUTYLPHTHALATE	5	0	<0.50	<0.50	?	?
008	DIETHYLHEXYLPHTHALATE	5	1	<4.00	<4.00	?	?
008	LINDANE	5	0	<0.05	<0.05	?	?
008	DDT	5	0	<0.05	<0.05	?	?
008	2,4,6 TCA	5	0	<0.30	<0.30	?	?
008	2,3,4,5 TECA	5	0	<0.30	<0.30	?	?
008	2,3,5,6 TECA	5	0	<0.30	<0.30	?	?
008	PCA	5	0	<0.30	<0.30	?	?
009	AROCLOR 1 2 4 2	14	0	<0.05	<0.05	?	?
009	DIMETHYLPHTHALATE	14	2	<0.30 - 24.18	0.87	6.99	0.00 -*****
009	DIETHYLPHTHALATE	14	0	<0.30	<0.30	?	?
009	DI-ISOBUTYLPHTHALATE	14	4	<0.30 - 9.06	0.06	16.94	0.00 - 3.20
009	DI-N-BUTYLPHTHALATE	14	3	<0.50 - 4.10	0.31	5.20	0.01 - 6.31
009	DIETHYLHEXYLPHTHALATE	14	4	<4.00 - 67.56	8.30	3.84	1.28 -53.87
009	LINDANE	14	0	<0.05	<0.05	?	?
009	DDT	14	0	<0.05	<0.05	?	?
009	2,4,6 TCA	14	0	<0.30	<0.30	?	?
009	2,3,4,5 TECA	14	0	<0.30	<0.30	?	?
009	2,3,5,6 TECA	14	0	<0.30	<0.30	?	?
009	PCA	14	0	<0.30	<0.30	?	?
22B	AROCLOR 1 2 4 2	18	0	<0.05	<0.05	?	?
22B	DIMETHYLPHTHALATE	18	2	<0.30 - 10.91	0.00	*****	0.00 -*****
22B	DIETHYLPHTHALATE	18	5	<0.30 - 2.66	0.94	1.80	0.48 - 1.84
22B	DI-ISOBUTYLPHTHALATE	18	3	<0.30 - 1.05	0.14	2.99	0.02 - 1.05
22B	DI-N-BUTYLPHTHALATE	18	0	<0.50	<0.50	?	?
22B	DIETHYLHEXYLPHTHALATE	18	6	<4.00 - 37.87	1.91	5.19	0.37 - 9.95
22B	LINDANE	18	0	<0.05	<0.05	?	?
22B	DDT	18	0	<0.05	<0.05	?	?
22B	2,4,6 TCA	18	0	<0.30	<0.30	?	?
22B	2,3,4,5 TECA	18	0	<0.30	<0.30	?	?
22B	2,3,5,6 TECA	18	0	<0.30	<0.30	?	?
22B	PCA	18	0	<0.30	<0.30	?	?

WATER FACTORY 21
SUMMARY DATA FOR BASE / NUETRAL CONSTITUENTS (FILE 1)
FOR PERIOD FROM 1APR80 TO 8APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	NAPTHALENE	29	1	<0.02	<0.02	?	?
001	ACENAPTHYLENE	29	0	<0.02	<0.02	?	?
001	PHENANTHRENE	29	1	<0.02	<0.02	?	?
001	ANTHRACENE	29	1	<0.02	<0.02	?	?
001	DI-N-BUTYL PHTHALATE	29	26	<0.10 - 5.06	0.94	3.10	0.59 - 1.48
001	FLOURENE	29	0	<0.02	<0.02	?	?
001	1,2,4 TRICHLOROBENZENE	29	12	<0.02 - 0.97	0.04	6.25	0.01 - 0.13
001	DIMETHYL PHTHALATE	29	0	<0.10	<0.10	?	?
001	DIETHYL PHTHALATE	29	17	<0.10 - 65.39	1.14	10.19	0.35 - 3.72
001	FLOURANTHENE	29	1	<0.02	<0.02	?	?
001	PYRENE	29	1	<0.02	<0.02	?	?
001	BUTYLBENZYL PHTHALATE	29	5	<0.10 - 37.59	0.00	*****	0.00 - 0.44
001	BIS(2-ETH. HEX.)PHTHAL	29	27	<0.10 -******	11.17	9.51	4.59 -27.16
001	DI-N-OCTYL PHTHALATE	29	5	<0.01 -******	0.00	*****	0.00 - 0.05
001	1,1,2,2 TETRACHLOROETH	29	0	<0.01	<0.01	?	?
001	---------	29	0	<0.10	<0.10	?	?
002	NAPTHALENE	16	4	<0.02 - 1.60	0.00	51.48	0.00 - 0.41
002	ACENAPTHYLENE	16	2	<0.02 - 0.04	0.01	1.80	0.00 - 0.08
002	PHENANTHRENE	16	1	<0.02	<0.02	?	?
002	ANTHRACENE	16	1	<0.02	<0.02	?	?
002	DI-N-BUTYL PHTHALATE	16	13	<0.10 - 6.19	0.21	3.88	0.09 - 0.47
002	FLOURENE	16	1	<0.02	<0.02	?	?
002	1,2,4 TRICHLOROBENZENE	16	7	<0.02 - 1.10	0.05	5.22	0.01 - 0.22
002	DIMETHYL PHTHALATE	16	0	<0.10	<0.10	?	?
002	DIETHYL PHTHALATE	16	10	<0.10 - 34.06	0.64	11.64	0.11 - 3.63
002	FLOURANTHENE	16	1	<0.02	<0.02	?	?
002	PYRENE	16	1	<0.02	<0.02	?	?
002	BUTYLBENZYL PHTHALATE	16	1	<0.10	<0.10	?	?
002	BIS(2-ETH. HEX.)PHTHAL	16	16	0.34 -391.40	2.41	6.04	0.93 - 6.24
002	DI-N-OCTYL PHTHALATE	16	1	<0.01	<0.01	?	?
002	1,1,2,2 TETRACHLOROETH	16	0	<0.01	<0.01	?	?
002	---------	16	0	<0.10	<0.10	?	?
004	NAPTHALENE	16	2	<0.02 - 0.08	0.00	7.39	0.00 - 1.01
004	ACENAPTHYLENE	16	1	<0.02	<0.02	?	?
004	PHENANTHRENE	16	0	<0.02	<0.02	?	?
004	ANTHRACENE	16	0	<0.02	<0.02	?	?
004	DI-N-BUTYL PHTHALATE	16	12	<0.10 - 2.42	0.18	3.54	0.08 - 0.41
004	FLOURENE	16	0	<0.02	<0.02	?	?
004	1,2,4 TRICHLOROBENZENE	16	1	<0.02	<0.02	?	?
004	DIMETHYL PHTHALATE	16	0	<0.10	<0.10	?	?
004	DIETHYL PHTHALATE	16	6	<0.10 - 19.76	0.19	17.87	0.01 - 3.37
004	FLOURANTHENE	16	0	<0.02	<0.02	?	?
004	PYRENE	16	0	<0.02	<0.02	?	?
004	BUTYLBENZYL PHTHALATE	16	0	<0.10	<0.10	?	?

WATER FACTORY 21
SUMMARY DATA FOR BASE / NUETRAL CONSTITUENTS (FILE 1)
FOR PERIOD FROM 1APR80 TO 8APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
004	BIS(2-ETH. HEX.)PHTHAL	16	15	<0.10 -301.40	1.19	5.53	0.46 - 3.04
004	DI-N-OCTYL PHTHALATE	16	0	<0.01	<0.01	?	?
004	1,1,2,2 TETRACHLOROETH	16	0	<0.01	<0.01	?	?
004	---------	16	0	<0.10	<0.10	?	?
006	NAPTHALENE	15	3	<0.02 - 0.28	0.00	11.27	0.00 - 0.36
006	ACENAPTHYLENE	15	1	<0.02	<0.02	?	?
006	PHENANTHRENE	15	2	<0.02 - 0.04	0.01	1.78	0.00 - 0.08
006	ANTHRACENE	15	1	<0.02	<0.02	?	?
006	DI-N-BUTYL PHTHALATE	15	11	<0.10 - 6.37	0.41	4.73	0.15 - 1.15
006	FLOURENE	15	0	<0.02	<0.02	?	?
006	1,2,4 TRICHLOROBENZENE	15	1	<0.02	<0.02	?	?
006	DIMETHYL PHTHALATE	15	0	<0.10	<0.10	?	?
006	DIETHYL PHTHALATE	15	9	<0.10 - 20.64	0.59	12.27	0.09 - 3.87
006	FLOURANTHENE	15	0	<0.02	<0.02	?	?
006	PYRENE	15	0	<0.02	<0.02	?	?
006	BUTYLBENZYL PHTHALATE	15	1	<0.10	<0.10	?	?
006	BIS(2-ETH. HEX.)PHTHAL	15	14	<0.10 - 30.50	1.25	5.86	0.46 - 3.44
006	DI-N-OCTYL PHTHALATE	15	0	<0.01	<0.01	?	?
006	1,1,2,2 TETRACHLOROETH	15	0	<0.01	<0.01	?	?
006	---------	15	0	<0.10	<0.10	?	?
008	NAPTHALENE	13	0	<0.02	<0.02	?	?
008	ACENAPTHYLENE	13	0	<0.02	<0.02	?	?
008	PHENANTHRENE	13	0	<0.02	<0.02	?	?
008	ANTHRACENE	13	0	<0.02	<0.02	?	?
008	DI-N-BUTYL PHTHALATE	13	13	0.11 - 2.86	0.31	2.86	0.17 - 0.58
008	FLOURENE	13	0	<0.02	<0.02	?	?
008	1,2,4 TRICHLOROBENZENE	13	0	<0.02	<0.02	?	?
008	DIMETHYL PHTHALATE	13	0	<0.10	<0.10	?	?
008	DIETHYL PHTHALATE	13	7	<0.10 - 16.97	0.82	11.19	0.09 - 7.03
008	FLOURANTHENE	13	0	<0.02	<0.02	?	?
008	PYRENE	13	0	<0.02	<0.02	?	?
008	BUTYLBENZYL PHTHALATE	13	0	<0.10	<0.10	?	?
008	BIS(2-ETH. HEX.)PHTHAL	13	13	0.11 -******	2.96	20.08	0.49 -17.86
008	DI-N-OCTYL PHTHALATE	13	3	<0.01 - 7.18	0.00	*****	0.00 -32.97
008	1,1,2,2 TETRACHLOROETH	13	0	<0.01	<0.01	?	?
008	---------	13	0	<0.10	<0.10	?	?
009	NAPTHALENE	27	0	<0.02	<0.02	?	?
009	ACENAPTHYLENE	27	0	<0.02	<0.02	?	?
009	PHENANTHRENE	27	1	<0.02	<0.02	?	?
009	ANTHRACENE	27	0	<0.02	<0.02	?	?
009	DI-N-BUTYL PHTHALATE	27	21	<0.10 - 5.12	0.24	4.25	0.12 - 0.46
009	FLOURENE	27	0	<0.02	<0.02	?	?
009	1,2,4 TRICHLOROBENZENE	27	0	<0.02	<0.02	?	?
009	DIMETHYL PHTHALATE	27	0	<0.10	<0.10	?	?

WATER FACTORY 21
SUMMARY DATA FOR BASE / NUETRAL CONSTITUENTS (FILE 1)
FOR PERIOD FROM 1APR80 TO 8APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
009	DIETHYL PHTHALATE	27	14	<0.10 -114.40	0.82	16.35	0.17 - 4.07
009	FLOURANTHENE	27	0	<0.02	<0.02	?	?
009	PYRENE	27	0	<0.02	<0.02	?	?
009	BUTYLBENZYL PHTHALATE	27	1	<0.10	<0.10	?	?
009	BIS(2-ETH. HEX.)PHTHAL	27	22	<0.10 -******	0.63	23.65	0.16 - 2.55
009	DI-N-OCTYL PHTHALATE	27	3	<0.01 - 1.08	0.00	*****	0.00 - 0.69
009	1,1,2,2 TETRACHLOROETH	27	0	<0.01	<0.01	?	?
009	---------	27	0	<0.10	<0.10	?	?
22B	NAPTHALENE	28	1	<0.02	<0.02	?	?
22B	ACENAPTHYLENE	28	0	<0.02	<0.02	?	?
22B	PHENANTHRENE	28	0	<0.02	<0.02	?	?
22B	ANTHRACENE	28	0	<0.02	<0.02	?	?
22B	DI-N-BUTYL PHTHALATE	28	21	<0.10 - 2.26	0.20	3.57	0.11 - 0.36
22B	FLOURENE	28	0	<0.02	<0.02	?	?
22B	1,2,4 TRICHLOROBENZENE	28	0	<0.02	<0.02	?	?
22B	DIMETHYL PHTHALATE	28	0	<0.10	<0.10	?	?
22B	DIETHYL PHTHALATE	28	15	<0.10 -******	0.32	31.40	0.05 - 2.11
22B	FLOURANTHENE	28	0	<0.02	<0.02	?	?
22B	PYRENE	28	0	<0.02	<0.02	?	?
22B	BUTYLBENZYL PHTHALATE	28	1	<0.10	<0.10	?	?
22B	BIS(2-ETH. HEX.)PHTHAL	28	23	<0.10 -******	1.18	14.58	0.37 - 3.75
22B	DI-N-OCTYL PHTHALATE	28	3	<0.01 - 0.39	0.00	9.08	0.00 - 0.28
22B	1,1,2,2 TETRACHLOROETH	28	0	<0.01	<0.01	?	?
22B	---------	28	0	<0.10	<0.10	?	?

WATER FACTORY 21
SUMMARY DATA FOR BASE / NUETRAL CONSTITUENTS (FILE 2)
FOR PERIOD FROM 1APR80 TO 8APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	X4	27	9	<0.10 -732.20	0.07	98.32	0.00 - 2.16
001	X11	27	24	<0.10 -122.70	7.39	5.49	3.61 -15.11
001	X12	27	14	<0.10 -106.10	0.11	20.74	0.02 - 0.60
001	X13	27	15	<0.10 - 51.29	0.20	12.01	0.05 - 0.79
001	TRIBUTYL PHOSPHATE	27	25	<0.10 - 62.35	5.00	4.21	2.77 - 9.05
001	X15	27	9	<0.10 - 4.68	0.12	8.48	0.02 - 0.60
001	X16	27	6	<0.10 - 1.71	0.07	5.90	0.01 - 0.39
001	X18	27	8	<0.10 - 4.90	0.19	6.45	0.04 - 0.88
001	X19	27	23	<0.10 -101.30	4.42	4.73	2.26 - 8.64
001	X21	27	6	<0.10 - 12.97	0.01	62.46	0.00 - 0.44
001	X22	27	21	<0.10 -127.40	4.13	6.76	1.73 - 9.83
001	X23	27	6	<0.10 - 6.98	0.01	30.08	0.00 - 0.23
001	OXAZOLIDINONE	22	8	<0.10 -******	1.44	72.43	0.04 -47.53
001	PEGAPE4	12	12	0.58 - 14.33	2.69	3.54	1.22 - 5.97
001	CAFFEINE	27	26	<0.10 - 59.64	3.59	5.81	1.76 - 7.30
001	BENZOTHIAZOLE	27	14	<0.10 - 3.15	0.20	4.54	0.08 - 0.48
002	X4	15	4	<0.10 -124.90	0.00	*****	0.00 -25.80
002	X11	15	13	<0.10 - 54.08	5.66	5.08	2.14 -14.99
002	X12	15	1	<0.10	<0.10	?	?
002	X13	15	2	<0.10 - 0.33	0.01	6.50	0.00 - 3.75
002	TRIBUTYL PHOSPHATE	15	15	0.31 - 23.78	3.60	3.58	1.78 - 7.26
002	X15	15	0	<0.10	<0.10	?	?
002	X16	15	0	<0.10	<0.10	?	?
002	X18	15	1	<0.10	<0.10	?	?
002	X19	15	13	<0.10 - 44.98	2.30	6.07	0.78 - 6.77
002	X21	15	1	<0.10	<0.10	?	?
002	X22	15	12	<0.10 -142.90	3.54	11.44	0.76 -16.43
002	X23	15	0	<0.10	<0.10	?	?
002	OXAZOLIDINONE	13	4	<0.10 -******	0.34	*****	0.00 -*****
002	PEGAPE4	7	6	<0.10 -157.80	2.26	21.68	0.10 -49.11
002	CAFFEINE	15	13	<0.10 - 18.61	1.87	6.88	0.59 - 5.94
002	BENZOTHIAZOLE	15	7	<0.10 - 2.22	0.21	4.54	0.06 - 0.83
004	X4	15	0	<0.10	<0.10	?	?
004	X11	15	14	<0.10 - 25.50	5.38	3.79	2.51 -11.53
004	X12	15	1	<0.10	<0.10	?	?
004	X13	15	0	<0.10	<0.10	?	?
004	TRIBUTYL PHOSPHATE	15	15	0.16 - 26.96	3.05	3.78	1.47 - 6.34
004	X15	15	0	<0.10	<0.10	?	?
004	X16	15	2	<0.10 - 1.51	0.00	71.89	0.00 -*****
004	X18	15	1	<0.10	<0.10	?	?
004	X19	15	13	<0.10 - 28.74	2.50	4.35	1.04 - 6.04
004	X21	15	0	<0.10	<0.10	?	?
004	X22	15	12	<0.10 - 51.90	2.76	7.10	0.81 - 9.49
004	X23	15	0	<0.10	<0.10	?	?

WATER FACTORY 21
SUMMARY DATA FOR BASE / NUETRAL CONSTITUENTS (FILE 2)
FOR PERIOD FROM 1APR80 TO 8APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
004	OXAZOLIDINONE	13	4	<0.10 -******	0.06	*****	0.00 -*****
004	PEGAPE4	7	7	0.46 - 9.74	1.98	3.56	0.64 - 6.14
004	CAFFEINE	15	15	0.13 - 17.16	1.75	5.90	0.66 - 4.64
004	BENZOTHIAZOLE	15	8	<0.10 - 4.49	0.14	8.04	0.03 - 0.79
006	X4	14	3	<0.10 -******	0.00	*****	0.00 -*****
006	X11	14	13	<0.10 - 71.80	3.34	6.74	1.07 -10.48
006	X12	14	6	<0.10 - 27.60	0.04	40.69	0.00 - 1.77
006	X13	14	5	<0.10 - 21.10	0.02	72.48	0.00 - 3.15
006	TRIBUTYL PHOSPHATE	14	11	<0.10 - 29.57	1.48	6.96	0.41 - 5.37
006	X15	14	0	<0.10	<0.10	?	?
006	X16	14	1	<0.10	<0.10	?	?
006	X18	14	2	<0.10 - 0.25	0.06	2.42	0.00 - 0.81
006	X19	14	10	<0.10 - 37.19	1.02	7.88	0.24 - 4.37
006	X21	14	0	<0.10	<0.10	?	?
006	X22	14	12	<0.10 - 99.40	4.83	6.96	1.43 -16.39
006	X23	14	0	<0.10	<0.10	?	?
006	OXAZOLIDINONE	10	4	<0.10 - 88.16	12.89	3.53	2.23 -74.44
006	PEGAPE4	6	6	0.11 - 10.13	1.54	6.11	0.25 - 9.41
006	CAFFEINE	14	12	<0.10 - 18.29	2.02	5.18	0.72 - 5.67
006	BENZOTHIAZOLE	14	6	<0.10 - 0.81	0.20	2.42	0.08 - 0.49
008	X4	12	1	<0.10	<0.10	?	?
008	X11	12	6	<0.10 - 9.70	0.20	6.82	0.03 - 1.38
008	X12	12	3	<0.10 - 2.72	0.03	15.65	0.00 - 4.55
008	X13	12	1	<0.10	<0.10	?	?
008	TRIBUTYL PHOSPHATE	12	5	<0.10 - 5.54	0.15	7.79	0.01 - 1.55
008	X15	12	0	<0.10	<0.10	?	?
008	X16	12	1	<0.10	<0.10	?	?
008	X18	12	0	<0.10	<0.10	?	?
008	X19	12	3	<0.10 - 1.91	0.02	21.00	0.00 - 4.73
008	X21	12	0	<0.10	<0.10	?	?
008	X22	12	4	<0.10 - 9.27	0.04	27.36	0.00 - 4.11
008	X23	12	0	<0.10	<0.10	?	?
008	OXAZOLIDINONE	9	4	<0.10 -******	0.07	*****	0.00 -*****
008	PEGAPE4	6	0	<0.10	<0.10	?	?
008	CAFFEINE	12	3	<0.10 - 4.18	0.00	68.89	0.00 - 7.15
008	BENZOTHIAZOLE	12	0	<0.10	<0.10	?	?
009	X4	20	6	<0.10 -368.70	0.01	*****	0.00 - 2.61
009	X11	20	5	<0.10 - 3.60	0.02	15.63	0.00 - 0.35
009	X12	20	2	<0.10 - 1.07	0.01	15.18	0.00 -25.74
009	X13	20	2	<0.10 - 3.70	0.00	*****	0.00 -*****
009	TRIBUTYL PHOSPHATE	20	11	<0.10 - 4.21	0.23	6.50	0.07 - 0.78
009	X15	20	0	<0.10	<0.10	?	?
009	X16	20	0	<0.10	<0.10	?	?
009	X18	20	0	<0.10	<0.10	?	?

WATER FACTORY 21

SUMMARY DATA FOR BASE / NUETRAL CONSTITUENTS (FILE 2)
FOR PERIOD FROM 1APR80 TO 8APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
009	X19	20	8	<0.10 - 2.15	0.09	5.80	0.02 - 0.37
009	X21	20	1	<0.10	<0.10	?	?
009	X22	20	7	<0.10 - 4.91	0.05	13.00	0.00 - 0.48
009	X23	20	1	<0.10	<0.10	?	?
009	OXAZOLIDINONE	16	8	<0.10 -285.90	1.52	24.61	0.11 -20.77
009	PEGAPE4	11	0	<0.10	<0.10	?	?
009	CAFFEINE	20	0	<0.10	<0.10	?	?
009	BENZOTHIAZOLE	20	1	<0.10	<0.10	?	?
22B	X4	22	5	<0.10 -383.20	0.08	74.29	0.00 -11.40
22B	X11	22	0	<0.10	<0.10	?	?
22B	X12	22	1	<0.10	<0.10	?	?
22B	X13	22	0	<0.10	<0.10	?	?
22B	TRIBUTYL PHOSPHATE	22	16	<0.10 - 3.88	0.34	4.20	0.16 - 0.72
22B	X15	22	0	<0.10	<0.10	?	?
22B	X16	22	1	<0.10	<0.10	?	?
22B	X18	22	1	<0.10	<0.10	?	?
22B	X19	22	6	<0.10 - 1.11	0.05	5.08	0.01 - 0.26
22B	X21	22	0	<0.10	<0.10	?	?
22B	X22	22	7	<0.10 - 2.04	0.10	5.12	0.02 - 0.43
22B	X23	22	0	<0.10	<0.10	?	?
22B	OXAZOLIDINONE	19	5	<0.10 -235.70	0.03	*****	0.00 - 7.82
22B	PEGAPE4	14	2	<0.10 - 0.31	0.06	2.63	0.00 - 1.12
22B	CAFFEINE	22	5	<0.10 - 1.14	0.15	2.79	0.04 - 0.48
22B	BENZOTHIAZOLE	22	1	<0.10	<0.10	?	?

WATER FACTORY 21
SUMMARY DATA FOR AP1 CONSTITUENTS
FOR PERIOD FROM 1AUG80 TO 4APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
001	2,4 DICHLOROPHENOL	24	9	<0.05 - 8.91	0.12	11.88	0.02 - 0.73
001	2,4,6 TRICHLOROPHENOL	24	13	<0.05 - 2.30	0.13	6.16	0.04 - 0.39
001	PENTACHLOROPHENOL	24	17	<0.05 - 19.91	1.25	3.98	0.61 - 2.53
001	LAURIC ACID	24	21	<0.05 - 44.03	4.96	4.63	2.47 - 9.94
001	3 HYDROXY LAURIC ACID	24	16	<0.05 - 40.73	1.86	7.56	0.64 - 5.45
001	MYRISTIC ACID	24	24	0.23 - 41.30	7.47	3.19	4.59 -12.17
001	PALMITIC ACID	24	23	<0.05 -222.70	22.19	4.48	11.61 -42.42
001	PENTADECANOIC ACID	24	14	<0.05 - 9.80	0.92	4.09	0.41 - 2.06
001	STEARIC ACID	24	24	0.15 - 96.14	13.01	4.04	7.23 -23.42
001	117 A	24	24	2.40 -123.10	14.09	2.82	9.11 -21.78
001	117 F	24	22	<0.05 - 32.61	3.38	4.56	1.73 - 6.60
001	117 H	24	19	<0.05 - 57.08	4.00	5.79	1.72 - 9.30
001	CLOFIBRIC ACID	24	23	<0.05 - 22.45	5.01	2.99	3.13 - 8.04
001	RESIN ACID A	18	7	<0.05 - 3.56	0.09	9.80	0.01 - 0.69
001	RESIN ACID B	18	10	<0.05 - 17.45	0.18	16.19	0.03 - 1.29
001	PHENOL	13	1	<0.05	<0.05	?	?
002	2,4 DICHLOROPHENOL	14	8	<0.05 - 3.12	0.52	3.70	0.18 - 1.51
002	2,4,6 TRICHLOROPHENOL	14	11	<0.05 - 0.83	0.36	2.17	0.22 - 0.61
002	PENTACHLOROPHENOL	14	10	<0.05 - 10.82	0.68	4.56	0.23 - 1.98
002	LAURIC ACID	14	12	<0.05 - 40.55	2.29	5.58	0.78 - 6.76
002	3 HYDROXY LAURIC ACID	14	9	<0.05 - 13.72	0.58	7.91	0.12 - 2.78
002	MYRISTIC ACID	14	14	0.67 - 59.48	5.87	4.37	2.52 -13.66
002	PALMITIC ACID	14	14	1.18 -108.70	9.98	4.31	4.33 -23.01
002	PENTADECANOIC ACID	14	11	<0.05 - 13.63	0.61	5.77	0.19 - 1.96
002	STEARIC ACID	14	14	0.27 - 37.56	3.82	4.49	1.62 - 9.01
002	117 A	14	13	<0.05 -170.10	7.35	4.67	2.92 -18.51
002	117 F	14	14	0.39 -135.10	3.96	5.06	1.57 -10.00
002	117 H	14	12	<0.05 -148.90	4.13	4.91	1.52 -11.24
002	CLOFIBRIC ACID	14	14	0.67 - 40.68	4.10	3.35	2.06 - 8.19
002	RESIN ACID A	12	11	<0.05 - 12.14	0.70	10.11	0.15 - 3.25
002	RESIN ACID B	12	9	<0.05 - 42.67	1.33	10.71	0.22 - 7.94
002	PHENOL	9	5	<0.05 - 12.00	1.80	3.94	0.37 - 8.71
004	2,4 DICHLOROPHENOL	14	5	<0.05 - 5.71	0.01	30.28	0.00 - 0.71
004	2,4,6 TRICHLOROPHENOL	14	7	<0.05 - 2.13	0.10	6.21	0.02 - 0.52
004	PENTACHLOROPHENOL	14	8	<0.05 - 10.87	0.29	10.39	0.04 - 1.97
004	LAURIC ACID	14	14	0.32 - 40.13	4.64	4.33	2.01 -10.74
004	3 HYDROXY LAURIC ACID	14	9	<0.05 - 9.41	1.20	4.40	0.39 - 3.67
004	MYRISTIC ACID	14	14	0.95 - 52.22	7.12	4.17	3.15 -16.10
004	PALMITIC ACID	14	14	2.20 -122.90	14.92	4.56	6.26 -35.54
004	PENTADECANOIC ACID	14	8	<0.05 - 11.15	0.30	7.66	0.06 - 1.58
004	STEARIC ACID	14	14	0.66 - 47.08	6.13	4.60	2.56 -14.68
004	117 A	14	13	<0.05 -151.60	14.27	4.09	6.14 -33.18
004	117 F	14	14	0.12 - 43.36	4.14	5.37	1.58 -10.83
004	117 H	14	14	0.89 - 58.22	6.91	3.53	3.36 -14.20

WATER FACTORY 21
SUMMARY DATA FOR API CONSTITUENTS
FOR PERIOD FROM 1AUG80 TO 4APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
004	CLOFIBRIC ACID	14	13	<0.05 - 24.58	3.45	3.99	1.50 - 7.89
004	RESIN ACID A	11	9	<0.05 - 26.52	1.72	7.14	0.39 - 7.56
004	RESIN ACID B	11	8	<0.05 - 50.57	3.26	6.98	0.67 -15.94
004	PHENOL	9	3	<0.05 - 5.60	0.48	5.05	0.02 - 9.34
006	2,4 DICHLOROPHENOL	11	3	<0.05 - 0.43	0.02	5.81	0.00 - 0.58
006	2,4,6 TRICHLOROPHENOL	11	1	<0.05	<0.05	?	?
006	PENTACHLOROPHENOL	11	7	<0.05 - 1.21	0.46	2.09	0.24 - 0.89
006	LAURIC ACID	11	10	<0.05 - 13.37	2.95	3.24	1.29 - 6.76
006	3 HYDROXY LAURIC ACID	11	9	<0.05 - 24.00	2.75	5.06	0.81 - 9.32
006	MYRISTIC ACID	11	11	0.88 - 24.99	5.32	2.92	2.61 -10.83
006	PALMITIC ACID	11	11	0.77 - 37.91	9.74	3.09	4.61 -20.59
006	PENTADECANOIC ACID	11	9	<0.05 - 4.54	0.68	4.24	0.23 - 2.02
006	STEARIC ACID	11	11	0.38 - 13.28	3.65	2.97	1.78 - 7.52
006	117 A	11	11	1.07 - 52.29	17.02	3.12	8.01 -36.18
006	117 F	11	10	<0.05 - 12.43	1.77	3.70	0.70 - 4.46
006	117 H	11	10	<0.05 - 16.30	4.57	2.73	2.25 - 9.26
006	CLOFIBRIC ACID	11	10	<0.05 - 19.89	3.28	4.46	1.14 - 9.42
006	RESIN ACID A	9	3	<0.05 - 1.56	0.32	3.23	0.04 - 2.74
006	RESIN ACID B	9	5	<0.05 - 12.77	0.32	14.10	0.02 - 6.78
006	PHENOL	6	0	<0.05	<0.05	?	?
008	2,4 DICHLOROPHENOL	11	0	<0.05	<0.05	?	?
008	2,4,6 TRICHLOROPHENOL	11	0	<0.05	<0.05	?	?
008	PENTACHLOROPHENOL	11	2	<0.05 - 3.18	0.00	*****	0.00 -*****
008	LAURIC ACID	11	9	<0.05 - 8.80	0.55	6.94	0.13 - 2.36
008	3 HYDROXY LAURIC ACID	11	5	<0.05 - 1.27	0.28	2.41	0.10 - 0.76
008	MYRISTIC ACID	11	11	0.71 - 16.23	4.37	2.94	2.14 - 8.94
008	PALMITIC ACID	11	11	2.78 - 51.93	15.98	2.79	8.10 -31.54
008	PENTADECANOIC ACID	11	9	<0.05 - 4.51	1.15	3.83	0.42 - 3.15
008	STEARIC ACID	11	10	<0.05 - 40.43	4.31	4.19	1.57 -11.83
008	117 A	11	8	<0.05 - 24.48	0.25	12.73	0.03 - 1.99
008	117 F	11	6	<0.05 - 3.16	0.29	4.86	0.06 - 1.40
008	117 H	11	6	<0.05 - 3.43	0.28	5.67	0.05 - 1.56
008	CLOFIBRIC ACID	11	6	<0.05 - 52.86	0.09	57.47	0.00 - 4.96
008	RESIN ACID A	8	2	<0.05 - 0.38	0.33	1.10	0.25 - 0.44
008	RESIN ACID B	8	2	<0.05 - 2.07	0.76	2.00	0.09 - 6.31
008	PHENOL	5	0	<0.05	<0.05	?	?
009	2,4 DICHLOROPHENOL	22	0	<0.05	<0.05	?	?
009	2,4,6 TRICHLOROPHENOL	22	0	<0.05	<0.05	?	?
009	PENTACHLOROPHENOL	22	1	<0.05	<0.05	?	?
009	LAURIC ACID	22	20	<0.05 - 12.99	1.75	3.05	1.04 - 2.95
009	3 HYDROXY LAURIC ACID	22	12	<0.05 - 2.85	0.24	3.59	0.11 - 0.54
009	MYRISTIC ACID	22	22	0.66 - 22.25	4.50	2.37	3.08 - 6.58
009	PALMITIC ACID	22	22	0.81 - 45.84	11.27	2.48	7.54 -16.83
009	PENTADECANOIC ACID	22	18	<0.05 - 5.20	0.95	2.94	0.56 - 1.62

WATER FACTORY 21
SUMMARY DATA FOR API CONSTITUENTS
FOR PERIOD FROM 1AUG80 TO 4APR81
(CONCENTRATIONS IN MICROGRAMS/LITER)

LOCATION	CHEMICAL	NUMBER OF DATA	NUMBER OF DATA ABOVE DETECTION LIMIT	RANGE OF DATA	GEOMETRIC MEAN	SPREAD FACTOR	95% CI
009	STEARIC ACID	22	22	0.61 - 20.13	5.25	2.41	3.56 - 7.73
009	117 A	22	8	<0.05 - 5.33	0.02	11.00	0.00 - 0.17
009	117 F	22	5	<0.05 - 5.74	0.00	37.67	0.00 - 0.29
009	117 H	22	5	<0.05 - 3.87	0.00	44.87	0.00 - 0.21
009	CLOFIBRIC ACID	22	2	<0.05 - 2.93	0.00	*****	0.00 -*****
009	RESIN ACID A	17	1	<0.05	<0.05	?	?
009	RESIN ACID B	17	5	<0.05 - 1.17	0.03	11.04	0.00 - 0.40
009	PHENOL	11	0	<0.05	<0.05	?	?
22B	2,4 DICHLOROPHENOL	20	0	<0.05	<0.05	?	?
22B	2,4,6 TRICHLOROPHENOL	20	0	<0.05	<0.05	?	?
22B	PENTACHLOROPHENOL	20	1	<0.05	<0.05	?	?
22B	LAURIC ACID	20	15	<0.05 - 17.49	0.57	8.47	0.18 - 1.85
22B	3 HYDROXY LAURIC ACID	20	1	<0.05	<0.05	?	?
22B	MYRISTIC ACID	20	20	0.29 - 34.44	3.78	3.24	2.18 - 6.56
22B	PALMITIC ACID	20	19	<0.05 -117.20	9.96	3.53	5.44 -18.23
22B	PENTADECANOIC ACID	20	10	<0.05 - 10.66	0.42	5.96	0.12 - 1.49
22B	STEARIC ACID	20	18	<0.05 - 48.72	3.43	3.75	1.79 - 6.60
22B	117 A	20	13	<0.05 - 3.90	0.07	17.38	0.01 - 0.36
22B	117 F	20	3	<0.05 - 0.99	0.00	*****	0.00 - 1.02
22B	117 H	20	0	<0.05	<0.05	?	?
22B	CLOFIBRIC ACID	20	2	<0.05 - 0.90	0.00	20.35	0.00 -30.51
22B	RESIN ACID A	16	0	<0.05	<0.05	?	?
22B	RESIN ACID B	16	0	<0.05	<0.05	?	?
22B	PHENOL	11	1	<0.05	<0.05	?	?

APPENDIX E

SUMMARY OF OPERATING PARAMETERS
MARCH 1978 THROUGH MARCH 1981

Units for each column given in heading at top to table except for column 5, fans, the code for which is as follows:

0 - Towers not in use
10 - One tower operating, no fans operating
11 - One tower operating, fans at low speed
20 - Two towers operating, no fans operating
21 - Two towers operating, fans at low speed

1E3KWH/WK = 1000 kilowatt hours/week
#/day = Pounds/day
MGD = Million gallons/day
GAC-OP = No. of GAC columns operating

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                                 GENERAL PARAMETERS (FILE 3)                          22:03 SUNDAY, MAY 23, 1982
         DATA FROM ORANGE COUNTY WATER FACTORY 21, WEEKLY SUMMARIES FOR 1MAR78-1APR81 (UNITS)
                        INFLUENT(MGD)      LIME(MG/L)      PH_Q2(1-14)      FANS(CODES)
                  GAC_INF(MGD)      GAC_OP(NUMBER)      GAC_REG(TONS/WK)      Q9_FLOW(MGD)
                   RO_FEED(MGD)      RO_PROD(MGD)      RECARBCL(#/DAY)      POST_CL(MG/L)
              WEEK_CL(TONS/WK)      AWT_NRG(1E3KWH/WK)      RO_NRG(1E3KWH/WK)      NAT_GAS(CU. FT./WK)

WEEK_OF INFLUENT LIME PH_Q2 FANS GAC_INF GAC_OP GAC_REG Q9_FLOW RO_FEED RO_PROD RECARBCL POST_CL WEEK_CL AWT_NRG RO_NRG NAT_GAS

06MAR78     9.12  500 11.25   20    8.04     12   20.00    4.04    4.00    3.38        .   47.34    5.62     105    155     236
13MAR78    10.41  500 11.22   11    9.91     13   39.00    4.77    5.14    4.33        .   64.93    9.03     175    220     432
20MAR78     9.11  500 11.29   11    9.07     15   35.00    4.40    4.67    4.05        .   13.00    4.85     100    235     275
27MAR78     9.94  500 11.40   11    8.79     12   35.00    3.76    5.03    4.25        .   20.00    9.88     143    161     254
03APR78     6.76  500 11.28   11    3.64     12   35.00    0.54    3.10    2.69      500   36.23    3.44      89    120     202
10APR78     5.39  500 11.23   11    4.74      7   36.00    0.00    4.74    4.07      500    0.00    1.81     116    219     218
17APR78     5.12  500 11.20   11    3.42      7   20.00    0.00    3.42    2.92      500    0.00    1.54      98    112     170
24APR78     6.80  500 11.36    0    4.93      7    0.00    0.00    4.93    4.12      500    0.00    2.45      90    171     104
01MAY78     5.41  500 11.51    0    4.50      7    0.00    0.00    4.50    3.90      750    0.00    2.69      98    107     139
08MAY78     6.30  500 11.39   20    5.73      7    0.00    0.00    5.73    4.97     1000    0.00    6.09     128    212     155
15MAY78     6.39  500 11.37   20    5.54      7   40.00    0.00    5.54    4.83        .    0.00   10.58     141    259     256
22MAY78     4.82  500 11.36   20    4.11      6   30.00    0.00    4.12    3.58     1000    0.00    4.35     105    167     209
29MAY78     4.77  500 11.43   20    3.51      6   25.00    0.00    3.51    2.46     1000    0.00    3.63      95    148     207
05JUN78     4.77  500 11.20   20    4.17      6   15.00    0.00    4.17    3.42        .    0.00    2.56     108    161     240
12JUN78     6.01  500 11.35   10    5.20      6   20.00    0.00    5.20    4.42     1000    0.00   13.50     209    300     414
26JUN78     0.00    .     .    .       .      .       .       .       .       .        .       .       .      21      3      44
03JUL78     0.00    .     .    .       .      .       .       .       .       .        .       .       .      33      7     108
10JUL78    10.04  500 11.27   20   10.53     13    0.00    5.65    4.88    4.23     1000   25.00    6.35     248    137     178
17JUL78    15.39  500 10.59   20   13.55     13    0.00    8.20    5.35    4.51     1000   25.00    9.70     109    257     214
24JUL78    16.10  300 10.50   20   14.06     14   50.00    8.20    5.86    4.97     1000   25.00   19.77     423    525     681
31JUL78    16.10  300 10.50   20   14.06     14   50.00    8.20    5.86    4.97     1000   25.00   19.77     423    525     681
07AUG78    16.31  300 10.37   20   13.95     14   30.00    8.60    5.35    4.53     1000   25.00   10.30     217    261     417
14AUG78    16.31  300 10.37   20   13.95     14   30.00    8.60    5.35    4.53     1000   25.00   10.30     217    261     417
21AUG78    15.27  300 10.56   20   12.68     15   50.00    8.43    4.25    3.58     1000   25.00   19.37     402    410     746
28AUG78    15.27  300 10.56   20   12.68     15   50.00    8.43    4.25    3.58     1000   25.00   19.37     402    410     746
04SEP78    15.74  300 10.47   20   13.69     14    0.00    7.96    5.73    4.87     1000   25.00    9.18     212    263    1269
11SEP78    17.08  300 10.45   20   15.01     14    0.00    9.06    5.95    5.10     1000   25.00    9.19     217    262    1067
18SEP78    17.87  300 10.73   20   16.44     14    0.00   10.60    5.74    4.87     1000   25.00   11.68     223    265    1234
25SEP78    16.11  300 10.64   20   16.03     14   20.00   10.67    5.06    4.31     1129   25.00    8.82     209    238    1469
02OCT78    17.67  300 10.89   20   16.47     14   25.00   10.61    5.86    4.99     1164   25.00   12.56     229    263    1454
09OCT78    11.08  300 11.02   20   10.92     14   20.00    5.16    5.76    4.90      700   25.00    5.64     155    259     975
16OCT78    11.45  300 10.91   20    9.11     14   10.50    3.89    5.22    4.62     1000   25.00    6.95     151    262    1023
23OCT78    14.19  300 10.82   20   12.96     15   10.00    7.70    5.26    4.47      892   25.00   15.67     366    480    2503
30OCT78    14.19  300 10.82   20   12.96     15   10.00    7.70    5.26    4.47      892   25.00   15.67     366    480    2503
06NOV78    17.72  300 10.69   20   16.70     14    0.00   11.28    5.42    4.61      762   25.00   11.10     220    259    1156
13NOV78    16.79  300 10.79   20   16.22     14   21.00   11.17    5.05    4.30     1000   25.00   10.92     206    254     936
20NOV78    16.95  300 10.79   20   15.49     15   15.00   10.27    5.22    4.44     1000   25.00   10.50     197    256    1337
27NOV78    15.30  300 11.05   20   13.88     14   10.00    8.96    4.94    4.20      928   25.00    8.90     164    252    1217
04DEC78    13.77  300 11.01   20   12.27     15   10.00    7.47    4.80    4.08     1000   25.00   13.98     311    512    2330
11DEC78    13.77  300 11.01   20   12.27     15   10.00    7.47    4.80    4.08     1000   25.00   13.98     311    512    2330
18DEC78    11.96  300 11.03   20   11.08     14    0.00    6.32    4.76    4.05      971   25.00    7.27     157    257    1017
25DEC78    13.52  500 11.34   10   12.73     14    0.00    7.64    5.09    4.32      856   25.00    8.60     189    257     947
01JAN79     9.26  500 11.02   20   11.59     13    0.00    7.04    4.55    3.87      621   25.00    5.49     128    254     725
08JAN79    15.46  500 10.95   20   14.83     14    0.00   10.32    4.51    3.88     1000   25.00   11.39     201    256     993
15JAN79    15.47  400 10.86   20   14.30     14    0.00    9.92    4.38    3.69     1000   25.00   10.84     207    249     908
22JAN79    11.87  400 11.06   20   11.49     14    0.00    7.25    4.24    3.55      754   25.00    7.18     167    260     805
29JAN79     8.31  400 11.10   20    7.72     16   30.00    3.46    4.26    3.56      518   20.00    4.02     246    226     926
05FEB79    14.55  400 10.85   20   13.27     15   30.00    8.73    4.54    3.89      949   20.00    8.52      76    260    1024
12FEB79    16.37  350 10.84   20   14.44     16   30.70    9.02    4.62    4.00     1007   20.00    9.50     213    220    1406
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                             GENERAL PARAMETERS (FILE 3)                          22:03 SUNDAY, MAY 23, 1982
            DATA FROM ORANGE COUNTY WATER FACTORY 21, WEEKLY SUMMARIES FOR 1MAR78-1APR81 (UNITS)
                      INFLUENT(MGD)        LIME(MG/L)        PH_Q2(1-14)       FANS(CODES)
                 GAC_INF(MGD)        GAC_OP(NUMBER)        GAC_REG(TONS/WK)        Q9_FLOW(MGD)
                  RO_FEED(MGD)        RO_PROD(MGD)        RECARBCL(#/DAY)        POST_CL(MG/L)
            WEEK_CL(TONS/WK)        AWT_NRG(1E3KWH/WK)        RO_NRG(1E3KWH/WK)        NAT_GAS(CU. FT./WK)

WEEK_OF INFLUENT LIME PH_Q2 FANS GAC_INF GAC_OP GAC_REG Q9_FLOW RO_FEED RO_PROD RECARBCL POST_CL WEEK_CL AWT_NRG RO_NRG NAT_GAS

19FEB79  14.36   350  10.91  20   12.53    16    28.33   8.75    3.78    3.25      1011      20     8.98     180     213    1038
26FEB79  13.70   400  10.94  20   12.28    15    14.80   8.15    4.13    3.46      1105      20     8.00     193     222    1173
05MAR79  13.81   500  11.27  20   12.17    14    22.12   7.38    4.79    3.99       945      20     7.18     203     244    1100
12MAR79  14.70   400  10.93  20   13.06    14    37.67   8.38    4.68    3.94      1000      20     8.30     201     255    1156
19MAR79  15.08   400  10.94  20   13.68    14    23.31   9.58    4.10    3.49       882      20     8.05     209     177     865
26MAR79  14.07   400  11.06  20   13.24    14    26.59   9.13    4.11    3.31       948      20     8.04     201     145       .
02APR79   7.38   450  11.12  20    6.28    14    72.92   1.71    4.57    3.04       474      20     5.97     267     441    1438
16APR79   6.74   450  11.20  10    4.67    15    28.51   0.00    4.67    3.99       350       0     2.10     132     255    1018
23APR79   6.32   400  11.16  10    4.63     7    33.69   0.00    4.63    3.92       350       0     2.04     114     255     591
09APR79   6.74   450  11.20  10    4.67    15    28.51   0.00    4.67    3.99       350       0     2.10     132     255    1018
30APR79   6.15   300  10.77  10    4.59     7    40.02   0.00    4.59    3.91       238       0     2.23      90     253     491
07MAY79   6.44   450  11.18  10    4.57     7    15.69   0.00    4.57    3.88       538       0     3.83     133     258    1035
14MAY79   6.48   400  10.95  10    5.31     8     0.00   0.51    4.80    4.06       586      20     3.52     128     255     751
21MAY79   6.45   400  11.00  10    5.49    10     0.00   0.67    4.82    4.09       352      20     2.43     121     245     674
28MAY79   5.39   400  10.96  10    4.25    10     0.00   0.56    3.69    3.14       458      20     2.34      90     159     640
04JUN79   6.98   400  11.00  20    5.39     9     0.00   0.58    4.81    4.07       500      20     2.55     127     266     680
11JUN79   6.84   400  11.00  20    5.54     9     0.00   0.76    4.78    4.09       500      20     2.52     128     245     739
18JUN79   6.87   400  10.90  20    5.21    12    16.95   1.16    4.05    3.44       500      20     2.47     327     253     971
25JUN79   6.98   400  11.02  20    4.59    11    30.23   0.89    3.70    3.15       500      20     3.13     118     222    1025
02JUL79   7.14   400  11.01  20    4.66    12    45.76   0.44    4.22    3.38       500      20     6.44     250     460    2008
09JUL79   7.38   400  11.19  20    5.35    11     9.92   0.65    4.70    3.99       500      20     2.82     121     256     834
16JUL79   7.38   400  11.19  20    5.35    11     9.92   0.65    4.70    3.99       500      20     2.82     121     256     834
23JUL79  11.44   450  11.21  20    8.05    14     0.00   3.10    4.95    4.13       510      20     3.19     108     128     530
30JUL79   6.31   500  11.36  20    4.80     9     0.00   0.41    4.39    3.72       500      20     2.41     113     242     751
06AUG79  11.98   500  11.30  20    8.33    14     0.00   3.55    4.78    4.02      1245      15       .      163     241     810
13AUG79   9.87   450  11.16  20    9.09    14     0.00   5.13    3.96    3.00       500      15     8.00     304     441    1432
20AUG79   9.87   450  11.16  20    9.09    14     0.00   5.13    3.96    3.00       500      15     8.00     304     441    1432
27AUG79  12.19   400  10.98  20   10.55    14     0.00   6.13    4.42    3.70       498      15     2.00     257     229     755
03SEP79  14.71   400  11.00  20   13.53    14     0.00   8.60    4.93    4.10       594      15     6.00      90     259     820
10SEP79  13.44   400  11.11  20   12.22    14     0.00   7.33    4.09    4.17       748      15     8.00     171     261     780
17SEP79  11.26   400  10.97  20   10.08    14     0.00   5.95    4.13    3.47       821      15     8.00     177     215     862
24SEP79  13.72   400  10.92  20   12.29    14     0.00   7.94    4.35    3.70       870      15     8.00     367     405    1743
01OCT79  13.72   400  10.92  20   12.29    14     0.00   7.94    4.35    3.70       870      15     8.00     367     405    1743
08OCT79  12.11   400  10.85  20   10.97    14     0.00   6.47    4.50    3.83       771      15     8.00     156     227     843
15OCT79  13.33   400  10.88  20   12.03    14     0.00   6.54    5.49    4.63       950      15     8.00     185     262     778
22OCT79  13.71   450  11.01  20   12.43    14     0.00   6.75    5.68    4.79       950      15     8.00     279     370    1329
29OCT79  13.08   400  10.73  20   11.48    12     0.00   6.85    4.63    4.07       950      15     0.00     110     255     650
05NOV79  13.10   450  10.90  20   11.85    13    43.43   6.69    5.16    4.36       983      15     8.00     191     249    1112
12NOV79  13.67   400  10.80  20   12.30    13    35.00   6.84    5.54    4.73       998      15     8.00     209     260    1067
19NOV79   9.64   400  10.67  20    9.84    13    30.00   4.23    5.61    4.64       642      15     8.00     165     270    1066
26NOV79  11.23   400  10.82  20    9.68    13    11.00   4.31    5.37    4.50       814      15     0.00     161     238    1004
03DEC79  10.54   400  10.78  20    9.37    12     0.00   4.84    4.53    4.03       885      15     8.00     172     250     680
10DEC79  10.37   450  11.00  20    9.07    12     5.00   4.45    4.62    3.87       817      15     0.00     147     196     816
17DEC79  10.33   400  10.84  20    9.00    12     0.00   4.50    5.32    4.50       867      15     8.00     170     254     778
24DEC79   7.77   425  10.97  20    7.78    12     0.00   2.15    5.63    4.72       614      20     8.00     206     370    1299
31DEC79   7.77   425  10.97  20    7.78    12     0,00   2.15    5.63    4.72       614      20     8.00     206     370    1299
07JAN80   7.50   500  11.13  20    5.75     6     0.00   0.00    5.75    4.88       500       0     0.00      56      87     602
14JAN80   7.41   500  11.26  20    5.22     9     0.00   0.00    5.22    4.46       600       0     0.00     124     233    1010
21JAN80   7.35   500  11.25  20    5.92     8     7.67   1.36    4.56    3.90       614      15     8.00     140     102    1000
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                                        GENERAL PARAMETERS (FILE 3)                          22:03 SUNDAY, MAY 23, 1982
                DATA FROM ORANGE COUNTY WATER FACTORY 21, WEEKLY SUMMARIES FOR 1MAR78-1APR81 (UNITS)
                              INFLUENT(MGD)      LIME(MG/L)      PH_Q2(1-14)      FANS(CODES)
                        GAC_INF(MGD)      GAC_OP(NUMBER)      GAC_REG(TONS/WK)      Q9_FLOW(MGD)
                         RO_FEED(MGD)      RO_PROD(MGD)      RECARBCL(#/DAY)      POST_CL(MG/L)
                  WEEK_CL(TONS/WK)      AWT_NRG(1E3KWH/WK)      RO_NRG(1E3KWH/WK)      NAT_GAS(CU. FT./WK)

WEEK_OF INFLUENT LINE PH_Q2 FANS GAC_INF GAC_OP GAC_REG Q9_FLOW RO_FEED RO_PROD RECARBCL POST_CL WEEK_CL AWT_NRG RO_NRG NAT_GAS

28JAN80     8.32  475 11.14   20    5.95      6   18.00    0.06    5.89    5.02      700    15.0       0     142    266    1470
04FEB80     8.31  475 11.11   20    5.99      9   16.70    0.09    5.90    5.04      612    15.0       0     144    265    1276
11FEB80     8.60  450 11.12   20    6.44      9   13.30    0.68    5.76    4.94      506       .       0     133    267    1270
18FEB80     9.38  475 11.14   20    7.23      9   11.93    1.37    5.86    5.00      790       .       0     282    266    1533
25FEB80     8.78  450 11.09   20    6.10     11    0.00    0.21    5.89    5.01      969       .       0     279    271     628
03MAR80     7.86  500 11.24   20    6.14     11    6.33    0.24    5.90    5.04      657       .       0     130    269    1148
10MAR80     6.59  450 10.99   20    5.09     14   19.24    0.69    4.40    3.82      600       .       0     135    219    1353
17MAR80    10.38  475 11.05   20    8.70     15    0.00    3.80    4.90    4.30      771       .       0     199    246    1416
24MAR80     5.07  475 11.15   20    0.01      9    0.00    0.01    5.37    4.36      500     0.0       0     229    455    1867
07APR80     7.07  450 11.07   20    0.19      8   22.93    0.19    5.15    4.47      500     0.0       0     131    248    1383
14APR80     3.26  475 11.19   10    0.93      2   20.00    0.93    1.62    1.36      300  1000.0       0     112     22     986
21APR80     1.08  500 11.26   10    0.63      1    0.00    0.63    0.00    0.00      263   142.7       0     185      2     165
28APR80     1.08  500 11.26   10    0.63      1    0.00    0.63    0.00    0.00      263   142.7       0     185      2     165
05MAY80     0.00    0     .    .    0.00      0    0.00    0.00    0.00    0.00        0     0.0       0       0      0       0
12MAY80     4.53  500 11.21   10    6.23     11    0.00    1.00    5.23    4.37      500    59.9       0     175     91     760
19MAY80     7.81  450 11.09   10    7.21     10    0.00    1.20    5.91    4.97      500    74.9       0     142    238     812
26MAY80     7.40  450 10.93   10    6.65      9    0.00    1.03    5.62    4.67      500    87.3       0     139    235     846
02JUN80     7.51  475 11.14   10    6.78     11    0.00    1.17    5.61    4.67      690    87.1       0     134    220     900
09JUN80     5.09  450 11.06   10    5.29      8    0.00    0.72    4.57    3.74      417   141.5       0      81     98     576
16JUN80     7.77  475 11.17   10    6.95     11    0.00    1.01    5.94    4.93      500   100.8       0     100    241     923
23JUN80     7.64  475 11.21   10    7.12     11   20.00    1.21    5.91    4.89      714    74.3       0     152    242    1122
30JUN80     7.04  450 11.05   10    6.88     11   15.00    1.31    5.57    4.56     1000    73.2       0     152    218    1122
07JUL80     6.83  500 11.34   10    6.42     12    6.57    0.93    5.49    4.50      700    77.3       0     130    194     918
14JUL80     6.83  500 11.34   10    6.42     12    6.57    0.93    5.49    4.50      700    77.3       0     130    194     918
21JUL80     6.83  500 11.34   10    6.42     12    6.57    0.93    5.49    4.50      700    77.3       0     130    194     918
28JUL80     6.83  500 11.34   10    6.42     12    6.57    0.93    5.49    4.50      700    77.3       0     130    194     918
04AUG80     6.83  500 11.25   10    6.08     10    0.00    1.18    4.90    3.98      700    71.1       0     170     95     448
11AUG80     7.01  500 11.28   10    6.95     11    0.00    1.09    5.86    4.79      700    77.0       0      44    233     683
18AUG80     7.56  475 11.14   10    7.02     11    0.00    1.19    5.03    4.79      700    70.5       0     160    235     705
25AUG80     7.41  450 11.08   10    6.96     10    0.00    1.18    5.78    4.70      700    71.1       0     144    229     646
01SEP80     7.07  450 10.99   10    6.93     11    0.00    1.22    5.71    4.65      700    68.8       0     140    233     687
08SEP80     6.49  450 11.10   10    6.32     12    0.00    0.81    5.51    4.50      829   103.6       0     140    230     677
15SEP80     7.32  400 11.06   10    6.83     11    0.00    1.24    5.59    4.57     1100    67.6       0     107    233     727
22SEP80     6.86  400 10.95   10    6.79     11    0.00    1.16    5.63    4.62      657    72.3       0     121    230     545
29SEP80     5.29  400 11.21   10    4.79      9    0.00    0.38    4.41    3.61      533    60.0       0     184    128     504
06OCT80     6.72  400 11.00   10    6.82     11    0.00    1.22    5.60    4.57      853    49.1       0     140    231     710
13OCT80     6.50  400 11.16   10    7.37     11   24.20    1.47    5.28    4.30      657    40.8       0     141    240    1008
20OCT80     6.47  400 11.03   10    7.36     11   34.04    1.13    5.16    4.17      973    53.0       0     145    221    1091
27OCT80     5.46  400 11.19   10    6.46     11   21.24    0.93    4.33    3.50      671    88.4       0     124    231     957
03NOV80     5.87  400 11.01   10    7.07     12   31.17    1.31    5.04    4.09      671    45.8       0     138    219    1043
10NOV80     5.84  400 11.15   10    6.52     12    0.00    1.07    5.06    4.20      748    56.0       0     129    213     792
17NOV80     5.76  400 11.05   10    6.75     11    0.00    0.82    4.97    4.02      700    60.0       0     135    228     708
24NOV80     6.49  400 10.99   10    7.04     11    0.00    1.07    4.85    3.89      700    56.0       0     134    228     744
01DEC80     6.06  400 10.97   10    6.83     11    0.00    1.25    4.68    3.73      529    51.0       0     136    225     777
08DEC80     5.47  400 10.93   10    6.62     11    0.00    1.58    4.77    3.83      692    37.9       0      88    124     471
15DEC80     0.00    .     .    .       .      .       .       .       .       .        .       .       0       0      0       0
22DEC80     0.00    .     .    .       .      .       .       .       .       .        .       .       0      26      6      60
29DEC80     0.00    .     .    .       .      .       .       .       .       .        .       .       0       0      0       0
05JAN81     0.00    .     .    .       .      .       .       .       .       .        .       .       0      19      .       9
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                                             GENERAL PARAMETERS (FILE 3)                    22:03 SUNDAY, MAY 23, 1982
                      DATA FROM ORANGE COUNTY WATER FACTORY 21, WEEKLY SUMMARIES FOR 1MAR78-1APR81 (UNITS)
                                  INFLUENT(MGD)      LIME(MG/L)      PH_Q2(1-14)      FANS(CODES)
                             GAC_INF(MGD)      GAC_OP(NUMBER)      GAC_REG(TONS/WK)      Q9_FLOW(MGD)
                              RO_FEED(MGD)      RO_PROD(MGD)      RECARBCL(#/DAY)      POST_CL(MG/L)
                        WEEK_CL(TONS/WK)      AWT_NRG(1E3KWH/WK)      RO_NRG(1E3KWH/WK)      NAT_GAS(CU. FT./WK)

WEEK_OF INFLUENT LIME PH_Q2 FANS GAC_INF GAC_OP GAC_REG Q9_FLOW RO_FEED RO_PROD RECARBCL POST_CL WEEK_CL AWT_NRG RO_NRG NAT_GAS

                                                                                                     8        19       .        9
12JAN81    0.00       .     .     .      .        .       .        .        .        .        .        .
19JAN81    5.06     400 10.90   10     5.70       7       0      0.72     3.79     3.04      500     83.0      0       194     173      480
26JAN81    4.35     400 11.16   10     4.83       9       0      2.40     3.48     2.82      606     44.1      8        99      99      617
02FEB81    6.21     400 11.06   10     7.06       9       0      1.09     5.04     3.93      693     88.0      0       138     222      780
09FEB81    5.23     400 10.98   10     6.03       8       0      1.06     4.98     3.84      671    114.0      8       123     223      699
16FEB81    5.22     400 10.88   10     6.21       7       0      0.99     4.74     3.65      700     99.2      8       121     217      716
23FEB81    4.39     400 11.03   10     5.88       8       0      1.12     3.52     2.70      700     99.4      0       125     151      677
02MAR81    3.96     400 11.10   10     4.90       9       0      1.97     4.79     3.69      614     56.8      8       118      97      721
09MAR81    5.85     400 11.15   10     6.75      10       0      1.15     5.15     4.04      643    104.0      8       280     383     1538
16MAR81    5.85     400 11.15   10     6.75      10       0      1.15     5.15     4.04      643    104.0      8       280     383     1538
23MAR81    6.37     400 11.13   10     6.85      11       0      1.07     4.99     3.97      900     95.0      8       131     218      808
30MAR81    6.15     400 11.17   10     7.65      10       0      1.24     5.54     4.46      787    129.0      8       149     217      869
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SUMMARY FOR 1 MARCH 78 THROUGH 31 MARCH 81

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                    GENERAL PARAMETERS (FILE 3)                       22:03 SUNDAY, MAY 23, 1982
        DATA FROM ORANGE COUNTY WATER FACTORY 21, WEEKLY SUMMARIES (UNITS)
                   INFLUENT(MGD)      LIME(MG/L)      FANS(CODES)
                 GAC_INF(MGD)      GAC_REG(TONS/WK)      Q9_FLOW(MGD)
          RO_FEED(MGD)      RO_PROD(MGD)      RECARBCL(#/DAY)      POST_CL(MG/L)
     WEEK_CL(TONS/WK)      AWT_NRG(1E3KWH/WK)      RO_NRG(1E3KWH/WK)      NAT_GAS(CU. FT./WK)

       VARIABLE         N        MINIMUM        MAXIMUM          MEAN        STANDARD
                                  VALUE          VALUE                       DEVIATION

       INFLUENT        159             0          17.87          8.86          4.38
       LIME            152             0         500.00        417.43         73.64
       GAC_INF         152             0          16.70          8.29          3.80
       GAC_REG         152             0          72.92         11.76         15.41
       Q9_FLOW         152             0          11.28          3.48          3.50
       RO_FEED         152             0           5.95          4.82          0.97
       RO_PROD         152             0           5.10          4.03          0.83
       RECARBCL        146             0        1800.00        736.76        244.81
       POST_CL         146             0        1000.00         42.75         86.50
       WEEK_CL         156             0          19.77          6.17          4.48
       AWT_NRG         159             0         423.00        166.56         81.21
       RO_NRG          157             0         525.00        237.87        105.45
       NAT_GAS         158             0        2503.00        856.61        485.04
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SUMMARY FOR 1 MARCH 80 THROUGH 31 MARCH 81

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                         GENERAL PARAMETERS (FILE 3)                    22:04 SUNDAY, MAY 23, 1982
             DATA FROM ORANGE COUNTY WATER FACTORY 21, WEEKLY SUMMARIES (UNITS)
                    INFLUENT(MGD)      LIME(MG/L)      FANS(CODES)
                  GAC_INF(MGD)      GAC_REG(TONS/WK)      Q9_FLOW(MGD)
          RO_FEED(MGD)      RO_PROD(MGD)      RECARBCL(#/DAY)      POST_CL(MG/L)
    WEEK_CL(TONS/WK)      AWT_NRG(1E3KWH/WK)      RO_NRG(1E3KWH/WK)      NAT_GAS(CU. FT./WK)

      VARIABLE          N        MINIMUM        MAXIMUM          MEAN        STANDARD
                                   VALUE          VALUE                     DEVIATION

      INFLUENT         56              0          10.38          5.46            2.43
      LIME             51              0         500.00        430.88           73.92
      GAC_INF          51              0           8.70          5.83            2.13
      GAC_REG          51              0          34.04          4.71            9.13
      Q9_FLOW          51              0           3.80          1.07            0.57
      RO_FEED          51              0           5.94          4.78            1.43
      RO_PROD          51              0           5.04          3.90            1.18
      RECARBCL         51              0        1100.00        643.63          186.50
      POST_CL          48              0        1000.00         93.96          137.36
      WEEK_CL          56              0           8.00          4.57            3.99
      AWT_NRG          56              0         280.00        129.34           57.31
      RO_NRG           54              0         455.00        189.35           96.60
      NAT_GAS          56              0        1867.00        761.79          406.10
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APPENDIX F

SUMMARY OF MUTAGENIC ASSAY DATA FOR XAD CONCENTRATES
STRAIN TA100 WITHOUT METABOLIC ACTIVATION
ACETONE CONCENTRATE

LOCATION: Influent (Q1)

	Net Revertants for Different Doses							Net Revertants Per Liter
Sample Date	10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	
12/25/79		51	106	147	110*			1224
12/31/79		81	99	106	193			688
01/25/80		40	53	115	100*			1043
02/04/80		29	51	61	33			—
02/19/80		30	32		82			—
02/28/80		5		61	58			—
03/10/80		84	62	133	149			519
03/25/80		42	28	11	25			—
04/14/80				82	39	33	11	—
04/22/80		25	30	67	42			—
04/25/80		12	33	85	85*			987
05/01/80			53	117	135		45*	1038
05/22/80			41	23	2		-35	—
06/27/80			24	61	51		57	—
07/04/80		46	43	11	30		-40	—

LOCATION: Chem. Eff. (Q2)

	Net Revertants for Different Doses							Net Revertants Per Liter
Sample Date	10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	
06/27/80			50	39	34		35	—
07/04/80		54	34	57	36		13	—

LOCATION: Stripp. Eff. (Q4)

Sample Date	Net Revertants for Different Doses							Net Revertants Per Liter
	10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	
06/21/80		33	35	40	51		61	--
07/04/80		31	49	57	54		36	--

LOCATION: Recarb. Eff. (Q6)

Sample Date	Net Revertants for Different Doses							Net Revertants Per Liter
	10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	
04/22/80		28	66	103	117			990
05/28/80			78	136	71*		20*	2360
06/17/80		41	41	70	108		129	572
06/21/80		71	83	138	257			2256
06/27/80			81	144	245		248	1083
08/12/80		70	141	238	336			3036
10/10/80			82	111	116		245	1012
10/10/80			30	204	307		355	1744
12/09/80			81	148	201		25*	1632
01/26/80			103	105	150		119*	413#
02/06/81			202	316	405		37*	1878
02/26/81			121	251	292		145*	991#
05/20/80			94	135	232		242	510
	49	45	59	164	250		-124*	1180

LOCATION: GAC Eff. (Q8)

Sample Date	Revertants for Different Doses							Net Revertants Per Liter
	10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	
04/22/80		8	27	14	-11			--
05/28/80			4	16	1		6	--
06/17/80		13	12	4	20		10	--
06/21/80		24	14	3	35		22	--
11/25/80			20	10	-10		-50	--
12/09/80			15	-2	-11		-27	--
01/26/80			41	38	37		26	--
02/06/81			18	19	21		43	--#

LOCATION: Chlor. Eff. (Q9)

Sample Date	Net Revertants for Different Doses 10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	Net Revertants Per Liter
12/25/79		60	95	168	197			820
12/31/79		142	233	394	565			2479
04/14/80				121	240	358	306*	1188
04/22/80		3	-4	13	18			--
04/25/80		36	39	76	116			501
04/29/80			1	13	15		1	--
05/01/80			47	93	128		186	826
05/22/80			37	38	108		121	540
05/28/80			74	117	249		246*	2400
06/02/80			9	75	105		153	758
06/17/80		45	83	114	215		339	1624
07/14/80		71	61	80	103		157	606
07/23/80		32	62	86	157		197	938
08/12/80		44	102	197	300			2906
08/17/80			79	111	201		264	1208
09/10/80			29	10	18		31	--
			3	6	4		4	--
09/18/80			43	72	96		137	584
10/10/80			52	102	151		215	972
			41	112	200		249	1204
11/10/80		14	2	6	22		78	--
11/25/80			29	55	79		92	392#
12/09/80			49	69	124		166	748
01/26/81			34	68	43		57	--
02/06/81			80	129	179		310	1384#
02/26/81			70	104	184		284	657#

LOCATION: RO Eff. (Q22B)

Sample Date	Net Revertants for Different Doses 10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	Net Revertants Per Liter
12/25/79		16	23	25	22			--
12/31/79		29	14	-2	-3			--
01/25/80		17	20	16	5			--
02/19/80		-10	-11	-10	-8			--
02/28/80		-7	-11	4	-8			--
03/10/80		-8	3	6	6			--
03/25/80		4	-5	-9	2			--
05/22/80			22	25	153 18		5	--

LOCATION: RO Eff. (Q22B) (continued)

Sample Date	Net Revertants for Different Doses 10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	Net Revertants Per Liter
08/17/80			15	14	-3		-11	--
09/18/80			24	9	13		24	--
11/10/80		0	-13	-11	2		-17	--

#Methanol fraction only

*Data not included in regression analysis

SUMMARY OF MUTAGENIC ASSAY DATA FOR XAD CONCENTRATES
STRAIN TA100 WITH METABOLIC ACTIVATION
ACETONE CONCENTRATE

LOCATION: Influent (Q1)

	Net Revertants for Different Doses							Net Revertants Per Liter
Sample Date	10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	
12/25/79		44	63	92	103			365
12/31/79		87	53	97	116			322
01/25/80		37	56	39	74			--
02/04/80		39	39	29	62			--

LOCATION: Chlor Eff. (Q9)

	Net Revertants for Different Doses							Net Revertants Per Liter
Sample Date	10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	
12/25/79		51	28	28	111			419
12/31/79		77	80	114	259			1113

LOCATION: RO Eff. (Q22B)

	Net Revertants for Different Doses							Net Revertants Per Liter
Sample Date	10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	
12/25/79		20	26	15	12			--
12/31/79		25	18	6	2			--
01/25/80		18	31	24	23			--

SUMMARY OF MUTAGENIC ASSAY DATA FOR XAD CONCENTRATES
STRAIN TA98 WITHOUT METABOLIC ACTIVATION
ACETONE CONCENTRATE

LOCATION: Influent (Q1)

	Net Revertants for Different Doses							Net Revertants
Sample Date	10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	Per Liter
12/25/79	14				66			285
12/31/79		24	24	53	68			287
01/25/80		-1	8	3	15			--
02/04/80		4		20	27			--
03/10/80		17	19	45	41*			398
03/25/80		11	8	19	19			--
04/14/80		-3	6	0	11			--
04/22/80		6	25	41	30*			888

LOCATION: Recarb. Eff. (Q6)

	Net Revertants for Different Doses							Net Revertants
Sample Date	10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	Per Liter
04/22/80		14	26	38	72			659

LOCATION: GAC Eff. (Q8)

	Net Revertants for Different Doses							Net Revertants
Sample Date	10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	Per Liter
04/22/80		12	1	-5	18			--

LOCATION: Chlor. Eff. (Q9)

	Net Revertants for Different Doses							Net Revertants
Sample Date	10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	Per Liter
12/25/79		11			31			127
12/31/79		18			127			655
04/14/80				47	57	72	82	150
04/22/80		3	-4	13	18			--

LOCATION: RO Eff. (Q22B)

Sample Date	Net Revertants for Different Doses							Net Revertants Per Liter
	10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	
12/25/79			5		8			--
12/31/79		19	6	10	8			--
01/25/80		5	7	-1	18			--
03/10/80		-8	3	6	6			--
03/25/80		4	-5	-9	2			--

SUMMARY OF MUTAGENIC ASSAY DATA FOR XAD CONCENTRATES
STRAIN TA98 WITH METABOLIC ACTIVATION
ACETONE CONCENTRATE

LOCATION: Influent (Q1)

Sample Date	Net Revertants for Different Doses 10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	Net Revertants Per Liter
12/25/79	14				38			--
12/31/79		26	22	39	41			--
01/25/80		12	5	29	47			--
02/4/80		18		31	37			--

LOCATION: Chlor Eff. (Q9)

Sample Date	Net Revertants for Different Doses 10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	Net Revertants Per Liter
12/25/79		6			7			--
12/31/79			2		34			--

LOCATION: RO Eff. (Q22B)

Sample Date	Net Revertants for Different Doses 10 µl	25 µl	50 µl	100 µl	200 µl	300 µl	400 µl	Net Revertants Per Liter
12/25/79			-5		-9			--
12/31/79		-3	-1	-8	-4			--
01/25/80		7	-8	0	-6			--

APPENDIX G

SUMMARY OF RECOVERY EFFICIENCIES FOR INDIVIDUAL ORGANIC COMPOUNDS AND SURROGATE STANDARDS (SS) WITH THE VARIOUS ANALYTICAL PROCEDURES USED

I. Volatile Organic Analysis (VOA)

Compound	Recovery (%)*
$CHCl_3$	45
Cl_3CCH_3	85
CCl_4	84
$CHClCCl_2$	108
$CHBrCl_2$	55
$CHBr_2Cl$	60
Cl_2CCCl_2	93
$CHBr_3$	62
BrH_2CCH_2Br (SS)	79

*average of recoveries at 0.2, 0.5, and 1.0 μg/l

II. Closed-Loop Stripping Analysis (CLSA)

Compound	Recovery (%)*
ethylbenzene	56
chlorobenzene	49
1,3-Dichlorobenzene	38
1,4-Dichlorobenzene	39
1,2-Dichlorobenzene	37
1,3,5-Trichlorobenzene	37
1,2,4-Trichlorobenzene	36
2-methylnaphthalene	34
1-methylnaphthalene	33
naphthalene	33
n-$C_8H_{17}Cl$ (SS)	62
n-$C_{12}H_{25}Cl$ (SS)	72
n-$C_{16}H_{33}Cl$ (SS)	70

*mean of recoveries at 100, 600, and 2000 ng/l

APPENDIX G

III. Hexane Extraction Analysis (HEA)

Compound	Recovery (%)
(A) Pesticides	
lindane	118
heptachlor	83
aldrin	76
dieldrin	91
4,4'-DDE	97
endrin	87
TDE	83
4,4'-DDT	99
methoxychlor	94
(B) PCB (Arochlor 1242)	
11 major Arochlor 1242 pks.	82
(C) Phthalic Acid Esters	
not determined (frequent contaminations and poor ECD response)	
(D) Chlorinated Anisoles	74
(E) hexabromobenzene (SS)	86

IV. Acid/Phenols (A/P)*

Compound	Recovery (%)
phenol	66
2-chlorophenol	16
2-nitrophenol	70
2,4-dimethylphenol	68
2,4-dichlorophenol	78
4-chloro-3-cresol	65
2,4,6-trichlorophenol	82
4-nitrophenol	85
2,4-dinotrophenol	75
4,6-dinitro-2-cresol	81
pentachlorophenol	94
4-bromophenol (SS)	65

*mean of two extractions at 5µg/l

APPENDIX G

V. Base/Neutrals (B/N)*

Compound	Recovery (%)
bis (2-chloroisopropyl) ether	54
hexachloroethane	57
N-nitrosodi-n-propylamine	90
nitrobenzene	39
isophorone	92
bis (2-chloroethoxy) methane	115
1,2,4-Trichlorobenzene	88
naphthalene	88
2-chloronaphthalene	90
acenaphthylene	99
dimethylphthalate	85
2,6-dinitrotoluene	87
acenaphthene	108
2,4-dinitrotoluene	67
fluorene	102
4-chlorophenyl phenyl ether	103
diethylphthalate	108
N-nitrosodiphenyl amine	110
4-bromophenyl phenyl ether	101
hexachlorobenzene	108
phenanthrene	92
anthracene	67
fluoranthene	78
pyrene	85
benzo (a) anthracene	73
chrysene	63
benzo (b) fluoranthene	59
benzo (a) fluoranthene	59
benzo (a) pyrene	52
indeno (1,2,3-cd) pyrene	50
dibenzo (a,h) anthracene	51
benzo (g,h,i) perylene	47
3,6-dimethylphenanthrene (SS)	93

*mean of two extractions at 5 μg/l and two at 10 μg/l